

DOCUMENT RESUME

ED 061 707

88

EM 009 598

TITLE INDICOM. (Individual Communications System). Final Report.

INSTITUTION Waterford Township School District, Pontiac, Mich.

SPONS AGENCY Office of Education (DHEW), Washington, D.C.

PUB DATE 30 Nov 70

GRANT OEG-67-04301-0

NOTE 100p.

EDRS PRICE MF-\$0.65 HC-\$3.29

DESCRIPTORS *Computer Assisted Instruction; *Demonstration Programs; *Educational Development; Educational Innovation; *Educational Research; Elementary Education; Experimental Schools; Federal Programs; Instructional Innovation; Programed Instruction; Programing; Teaching Methods

IDENTIFIERS Elementary and Secondary Education Act Title III; INDICOM; Individual Communications System; SIMPLE

ABSTRACT

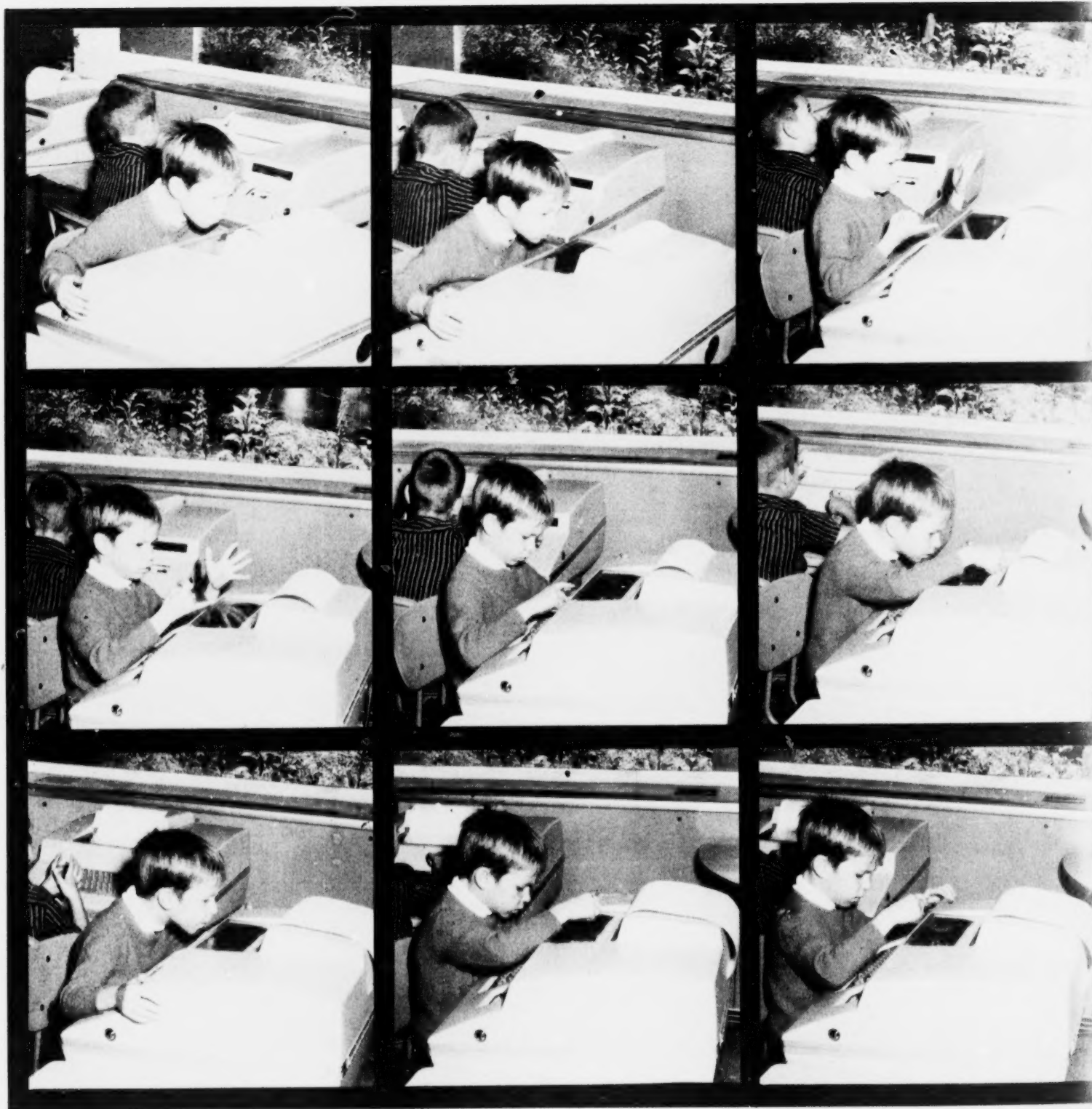
The Individual Communications System (INDICOM) was begun in 1967 in Waterford School District, Michigan, as one of the first public school computer-assisted instruction projects in the Midwest. Its specific aim in developing CAI was to fuse the latest technology with the best thinking in education so as to create an instructional system which would allow each student to enter at his own level and to proceed at his own pace. This document serves as a yearbook and complete description of the program and its personnel. INDICOM's directors maintained the thesis that instructional innovation must begin with the teachers (who were trained in CAI program design) or it will end outside the classroom door. Full description of the development of all aspects of the program is given. The feeling is expressed throughout that INDICOM's experience has been a great success and that it documents the potential of computer instruction in individualizing teaching and in solving the problems of U.S. public education. (RB)

ED 061707

indicom

Waterford - District

EM 009 5-98



INDICOM
(Individual Communications System)

ESEA Title III Project Providing an In-depth Exploration
of the Potential of Computer-Assisted-Instruction (CAI)
and a Study and Evaluation of Other Computer Applications
to Learning: OEG 67-04301-0

FINAL REPORT
TOTAL PROJECT OPERATION

For the Period August 1, 1967
through November 30, 1970

WATERFORD SCHOOL DISTRICT
6020 PONTIAC LAKE ROAD
PONTIAC, MICHIGAN 48054

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRO-
DUCED EXACTLY AS RECEIVED FROM
THE PERSON OR ORGANIZATION ORIG-
INATING IT. POINTS OF VIEW OR OPIN-
IONS STATED DO NOT NECESSARILY
REPRESENT OFFICIAL OFFICE OF EDU-
CATION POSITION OR POLICY.

CONTENTS

Introductory Letter from Project Director Ronald Arnold	
Dedication to the late Dr. Don O. Tatroe	
Introduction	
Waterford Boards of Education	
Expression of Appreciation	
Preface	
INDICOM Professional Staff	

Section I - Hardware Selection	1
Section II - Who will Develop CAI?	3
Design Team Members	4
Training Classroom Teachers as Authors	5
SIMPLE - The INDICOM-Developed Language	8
Section III - The First INDICOM CAI Laboratory	11
Section IV - Installation of the I-71 System	18
I-71 Components	21
Section V - Evaluation	22
Objectives 1 & 2	23
Objective 3	24
Objectives 4 & 5	27
Objective 6	28
Objective 7	29
Section VI - Effects of INDICOM	30
Significant Project Dates	33
Section VII - Introduction to Section Describing	
Activities of Each Design Team	34
Design Team CAI Program Chart	35
Business Team	36
Classroom Management	38
Language Arts	40
Mathematics	42
Music	44
Reading	46
Science	50
Social Studies	52
Spelling	53
Section VIII - Summary of the Activities and Findings	
of the INDICOM Project	55
INDICOM and Accountability	56
SAT Mathematics Test Chart	57
Objectives and Accomplishments	58
Attitude Survey Chart	59
Problems and Serendipity	62
Dissemination	64
Funding of Project Activities	64
Section IX - Glossary	67



Waterford School District

INDICOM[®] A PACE Project

DR. JOHN PAGEN
Superintendent

RONALD ARNOLD
Director

1325 Crescent Lake Road Pontiac, Michigan 48054
(313) 674-4141

November, 1970

As the first public school Computer Assisted Instruction (CAI) project in the midwest, INDICOM not only has had a pioneering role in CAI but has taken a unique approach to its "education tomorrow" task.

Classroom teachers from the Waterford School District have been deeply involved in the project in the preparation of curriculum materials for presentation under computer control. The fruits of their work along with some commercially developed curricula, are transmitted via RCA electronic equipment to students at Waterford's Riverside Elementary School and Waterford Mott High School.

At the outset of the project, 32 instructional terminals were housed at Riverside and connected to an RCA Spectra 70/45 computer system in Palo Alto, California. With the installation of the new RCA I/71 computer system in December of 1969 at Mott, 16 of the terminals were moved to Mott. All 32 terminals were then connected to the on-site computer with audio and graphics enhancements added in March, 1970.

A Title III Pace Project, INDICOM began in August, 1967 and was planned for three years. Its aim has been to fuse the latest in technology with the best thinking in education to permit each child to learn at his own rate and up to his full potential. The most critical part of the project has been the creation of instructional programs that take full advantage of existing technology to enable each youngster to enter the curriculum at his proper level and proceed at his own rate. Evaluation of the effectiveness of the INDICOM-developed instructional materials to date has been handicapped by delays in the installation schedule and is not conclusive at this point. However, the commercial curricula employed in the project has proven to be very effective.

A total of \$1,158,531. has been granted to INDICOM through Title III and an additional \$153,650. will be forthcoming in 1971 from Title III to meet the final obligation on the computer system.

INDICOM has been totally administered by public school personnel. The Waterford Board of Education and Superintendent, Dr. John Pagen, have been fully supportive of the INDICOM effort as has the State of Michigan Department of Education.

Ronald Arnold

Ronald Arnold
Director, INDICOM



CAI - A Forward Step in Education

This Publication Is Dedicated
To The Memory Of:

DR. DON O. TATROE
(June 25, 1928 - May 11, 1970)

Dr. Tatroe, Superintendent of the Waterford School District from January 28, 1963 to July 1, 1969, was truly outstanding both as an educational leader and as a man. He was a meticulous teacher and administrator but not an excessive perfectionist. He had a systematic, scientific approach to problems and was always well prepared with details. He was a devoted family man and church leader whose greatest concern was the quality of people's living. His competency to lead and motivate people was excelled only by his artistic touch in human relations.

His immediate impressiveness as a leader and a man is probably best illustrated by his being selected "Outstanding Young Man Of The Year" by the Waterford Junior Chamber of Commerce in 1963. The honor was bestowed within a full year of his arrival in Waterford. He was active in many civic organizations. He served as Chairman of the Pontiac Area United Fund in 1966 and was designated "Outstanding Boss" by the Waterford Jaycees in 1969. He was also active in several educational organizations and authored seven published documents between 1954 and 1969. His Bachelor's, Master's and Doctoral degrees were all earned at Michigan State University and in 1965 he participated in an Advanced Graduate Institute at Harvard University.

Dr. Tatroe's superior capabilities as an educator became known nationally and numerous opportunities arose outside the state in deanships and some of the larger superintendencies, but he chose to remain in Michigan. He served as Executive Director of the Michigan Association of School Boards from July 1, 1969 until his untimely death on May 11, 1970.

INTRODUCTION

It is doubtful there exists a single American whose life is not affected by computer science. We are counted, paid, analyzed, evaluated, billed, taxed, scheduled, serviced and even entertained via the machinations of the mysterious beast. The public schools also are affected. Responsible educators have already discovered that they cannot afford to ignore the impact of the electronic computer on the American way of life and its significance to future generations.

In the 70's no school should be without some instruction to acquaint students with the functions and significance of computers in science, industry and government. No secondary school that pretends to offer worthwhile vocational and scientific training to students should be without electives in computer science.

The foregoing statements are made without equivocations and they are based on easily observable fact. However, the major concern of this report has to do with a pioneering use of the computer in education that perhaps deserves more searching discussion in terms of justifying the cost and effort that the INDICOM Project presents.

Besides dazzling the eye and piquing the imagination, can computers be used to make instruction better than it is already? In addition to expediting certain administrative and clerical functions, does computer technology hold any promise for solving the multitude of problems that beset the American public school system? The INDICOM Project furnishes evidence that a resounding YES is the correct response to both of these questions.

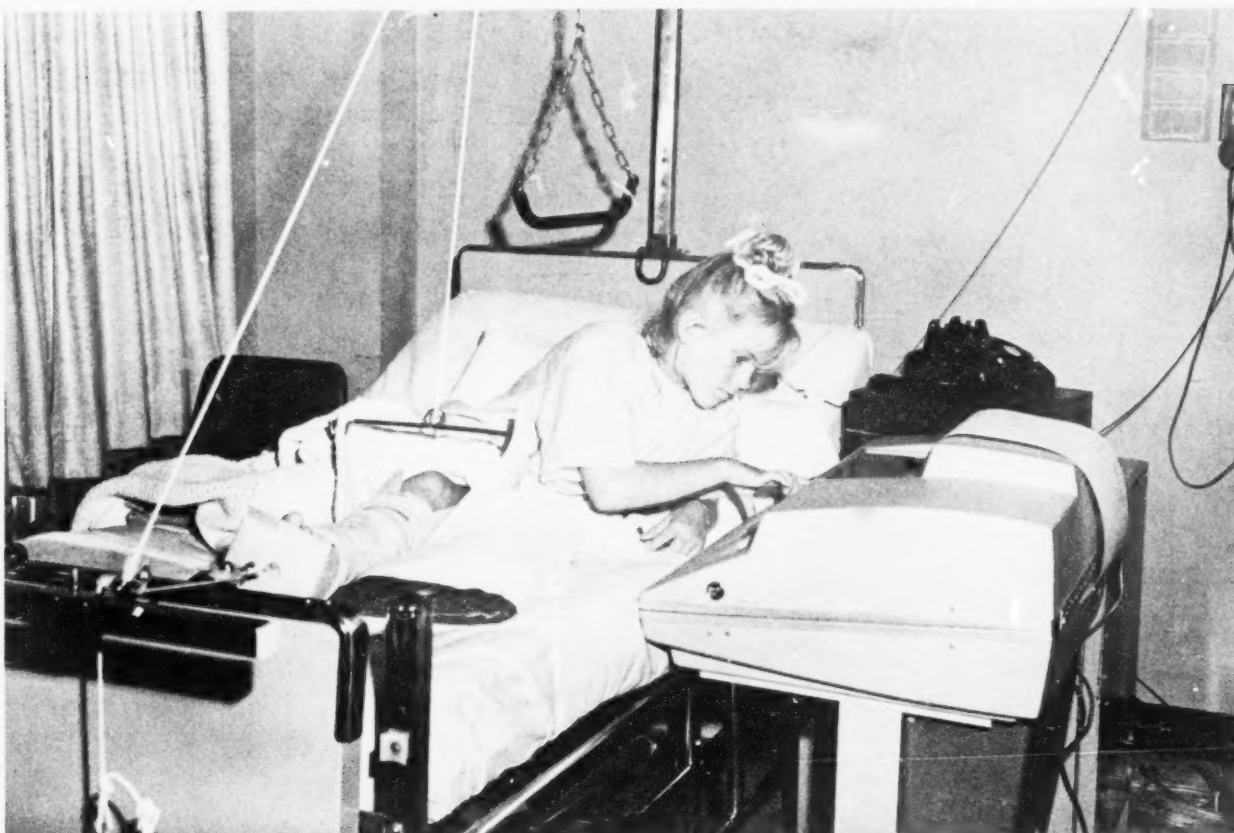
Children are probably responsible for a major portion of the troubles of the American school system. If there were no children to educate, the problems of the schools would undoubtedly be reduced by at least one half. Administrators would need concern themselves only with the problems of teachers, materials, and facilities. Foolish conjecture? Certainly - the point to be made is that to solve the school problems, educators should focus first on the students themselves rather than the teachers, administrators, materials and facilities. Unfortunately few problem solving efforts in education seem to begin with children. The INDICOM Project is about children.

Public schools are required by law to furnish education to ever increasing numbers and varieties of children. Furthermore, merely keeping youngsters in school is no longer considered education per se. Traditionally, instruction has been planned for homogeneous groups of youngsters with fairly similar backgrounds, experience patterns, values, etc. But homogeneous student bodies do not exist in many school systems. In fact it is commonly recognized today that every youngster comes equipped with a unique set of variables that determines to some extent how he learns.

The child who fares best in the traditional school setting is generally one who is able to manipulate visual symbols with ease, follow instructions, obey rules and sit quietly for several hours each day.

If we are to solve a portion of the problems of public school systems, it would seem we must find the means of insuring that those youngsters who are endowed with different sets of learning abilities each have an equal opportunity to become educated. In other words, we must attempt to provide instruction that permits every child to use whatever talents and aptitudes he has to realize his full learning potential.

The electronic computer with its high speed information processing and decision-making capabilities appears to be the most promising tool for discovering the learning aptitudes of youngsters and for identifying and administering the kinds of instruction that each youngster can assimilate efficiently. The INDICOM Project has been a pioneering and effective effort in utilizing the computer for this purpose.



Michelle Thomas didn't let a broken leg interfere with her 6th grade summer CAI program. A terminal was installed in her hospital room where she kept pace with her peers at the Riverside CAI Lab.

INDICOM Project Director, Ronald Arnold, discusses the CAI procedure with Sue Dotson, a senior at Mott High School. The aid of high school students has been an important factor in the success of the INDICOM Project.





Kathy Brown, 6th grader at Riverside School, performs a CAI lesson at the terminal as teacher C. Wayne Johnson looks on.

Dr. Hal Wilson, Director Division of Instructional Systems, Harcourt, Brace, Jovanovich Inc., addresses news media representatives and educators at INDICOM's March 6, 1970 news conference.



WATERFORD SCHOOL DISTRICT
BOARDS OF EDUCATION

	<u>1967-68</u> <u>INDICOM Inception</u>	<u>1970-71</u> <u>Project Conclusion</u>
President	Eldon C. Rosegart	Philip M. Hampton
Secretary	M. Virginia Ross	M. Virginia Ross
Treasurer	Donald W. Porter	Lewis S. Long
Trustee	John D. Boardman	Stanley W. Kurzman
Trustee	Robert E. Field	Eldon C. Rosegart
Trustee	Lewis S. Long	Louis H. Schimmel
Trustee*	[Michael G. Patterson [Philip M. Hampton	John F. Volkert
	Dr. Don O. Tatroe, Superintendent of Schools	Dr. John Pagen, Superintendent of Schools

*Mr. Patterson resigned midway in the fiscal year and Mr. Hampton was appointed to fill the vacancy.

APPRECIATION IS EXTENDED TO
THE FOLLOWING EDUCATORS FOR
THEIR VALUABLE CONTRIBUTION TO
THE SUCCESS OF INDICOM:

The late Mr. Don Goodson,
Title III Coordinator,
Michigan Department of
Education

Mr. Goodson was most helpful
and his valued counsel was
always readily available
whenever it was sought.

Dr. Peggy Miller,
Title III Consultant,
Michigan Department of
Education

Dr. Miller has provided
continuing assistance and
understanding in the manage-
ment of this complex project.

Dr. John Pagen,
INDICOM Director 1967-1969,
now Superintendent,
Waterford School District

Dr. Pagen provided excellent
leadership as INDICOM Director
and has maintained a vital
interest in the project.

Mr. Roy Alexander,
Assistant Superintendent,
Waterford School District

Mr. Alexander prepared the
initial INDICOM proposal and,
more than anyone else, was
responsible for Waterford's
being awarded this major
project.

Design Team Members

The people with the vital
assignment of designing
curriculum for presentation
under computer control.

Miss (Lois) Jerry Blanchard

Former Instructional Materials
Specialist with the project.

Mrs. Cheryl Cobb

Former Librarian with the
project.

Mr. Charles Welsh

Riverside Principal and member
of the Science Design Team.

Mr. Dan Hogan

Former Waterford Mott Principal

Mr. William Aebersold

Present Waterford Mott Principal

The INDICOM, Riverside and Waterford Mott Staffs

The Waterford Education Association

The Total School District Staff

PREFACE

INDICOM, launched in August, 1967 in the then 17,666 enrollment Waterford School District located 30 miles northwest of Detroit, quickly won recognition as one of the outstanding major Title III projects in the nation. More recently, INDICOM has been regarded by many educators as one of the most sophisticated CAI efforts in existence.

The general objectives of INDICOM have been:

- (1) To fuse the latest in technology with the best thinking in education to individualize instruction and permit each child to learn at his own rate and up to his full potential.
- (2) To utilize the knowledge, skill and experience of top level teachers for the purpose of creating units of instruction which effectively employ the instructional computer system in combination with other appropriate media to improve and individualize the instructional process.

Seven specific objectives were established from the two general objectives. These specific objectives are analyzed in the EVALUATION Section of this report.

With the basic premise of the INDICOM Project that working teachers can develop CAI curriculum as expertly as anyone, some 40 full time Waterford teachers were trained at the outset as CAI authors. They have produced more than 1,200 lessons for presentation under computer control. The INDICOM staff has employed a systems approach to curriculum creation, specifying curriculum development in behavioral terms, sequencing instruction and using pre and posttests measures to determine if the instructional model is appropriate and effective.

The contribution of INDICOM to CAI has been very significant. Thorough analysis of evaluation data clearly demonstrates that CAI is more effective than traditional classroom instruction and that the computer is a viable medium for instruction in a public school system.

INDICOM Director Ronald Arnold termed the high achievement of the Waterford CAI students in comparison to control groups as "a major breakthrough in the documentation of the potential of computer applications to learning." Former INDICOM Director and now Superintendent of Waterford Schools, Dr. John Pagen, made this observation: "The computer as a tutor, an idea

that drew more skepticism than support a few years ago, now is emerging as a very realistic fact of educational life."

"Findings of the INDICOM project clearly document that CAI students have out-distanced students of comparable ability both in achievement and in positive attitude toward education."

Individualized Communication, from which INDICOM derives its name, provides the key to CAI effectiveness.

INDICOM PROFESSIONAL STAFF

RONALD ARNOLD, DIRECTOR

B.A. Michigan State University

M.A. Michigan State University

As the chief administrative official and project coordinator, the Director has been responsible for the overall direction of the project.

Mr. Arnold also has been in charge of developing suitable training programs and experiences for design teams and participating staffs.

NICHOLAS A. MENGhini, TECHNOLOGICAL SERVICES SPECIALIST

B.A. Northern Michigan University

M.A. University of Michigan

Doctoral Program, University of Michigan

Coordinating relations with the vendor concerning hardware acquisition, installations and acceptance, and coordinating the site development effort have been the chief responsibilities of the Technological Services Specialist. As the Director of Data Processing for the Waterford School system, Mr. Menghini has acted as a consultant to the INDICOM Project.

JOSEPH B. MULLEN, INFORMATION SERVICES SPECIALIST

B.A. University of Detroit

The Information Services Specialist's main responsibility has been dissemination of project information to national and state agencies, educators, news media and the public. He has also served as office manager.

ALFRED PAVLISH, INSTRUCTIONAL TECHNOLOGIST

B.A. St. Cloud State College

M.A. University of Minnesota

The Instructional Technologist has devised and adapted the software to handle the curriculum data base. Mr. Pavlish has also been responsible for computer operations at the Mott and Riverside CAI sites.

MRS. RUTH PENNY, CURRICULUM EDITOR

B.A. Michigan State University

M.A. Michigan State University

The Curriculum Editor's primary responsibility has been to work with the design teams and Instructional Technologist in the creation and programming of instructional units.

DR. ROBERT W. SCRIVENS, RESEARCH AND MATHEMATICS SPECIALIST

A.B. Eastern Michigan University

A.M. University of Michigan

Ed.D. University of Michigan

The primary responsibility of the Research Specialist has been to collect and analyze data for the evaluation of the instructional programs and other project objectives. Dr. Scrivens has also supervised the development of mathematics materials.

DARRYL SMITH, GRAPHICS SPECIALIST

B.A. Michigan State University

M.A. Wayne State University

Plans to enter Doctoral Program at W.S.U. in summer, 1971.

The Graphics Specialist has been supervising the design and production of audio and graphic materials for teaching units.

Mr. Smith also assists the Instructional Technologist in operations and programs.

* * * * *

DR. JOHN PAGEN, SUPERINTENDENT, WATERFORD SCHOOL DISTRICT
INDICOM DIRECTOR 1967-1969

B.S. Ferris State College

M.S. Wayne State University

Ed.D. Wayne State University

Dr. Pagen served as INDICOM Director from September, 1967 when the project began until December, 1969 when he was appointed Superintendent of the Waterford School District.

The INDICOM Project Is Not Hardware Fixated; Its Purpose Is To
Develop Instruction That Accommodates Learners--Not Computers.

HARDWARE SELECTION

A full time professional staff was recruited before the INDICOM Project got underway. With this accomplished, the immediate concern was to locate a computer system (hardware) vendor who could provide both the equipment and corporate support required by INDICOM.

In selecting the hardware configuration, INDICOM and school district officials scrutinized the vendors as carefully as they did the specifications of the proposed computer systems.

Evidence of corporate commitment to education and the ability of the vendor to provide continuing support throughout the project were prime factors influencing the final decision. The immediate availability of documented curriculum materials as well as the capabilities of the system were also important considerations.

Working with Waterford Schools and INDICOM administrators in this effort were Dr. John Childs of Wayne State University, Dr. Karl Zinn of The University of Michigan and Dr. Norman Bell of Michigan State University. All three were retained as consultants by the INDICOM Project.

Proposals were submitted by three companies: Technomics, RCA and IBM. Technomics later withdrew its offer. The final selection was preceded by numerous meetings with vendors, live demonstrations, inspection tours and meticulous analysis of the details and contingencies of the written specifications of the proposed system.

The conclusions reached by the school district and INDICOM officials, aided by consultants, were summarized by the project director, Dr. John Pagen, in his recommendations to the Waterford School Board dated December 21, 1967.

1. In considering the overall contacts between the two vendors, RCA has committed itself more completely to move into the area of CAI and give the type of support that is necessary if the Waterford School District is to succeed in the INDICOM Project. The lines of communication appear to go much higher in RCA, and this should make it easier to bring about the kinds of changes and action that will be needed in a project subject to as many variables as is INDICOM.

2. The RCA I/71 System has greater capacity for storage and has a capability for immense growth in this area. It appears to be more aptly suited to tying in to a large computer system.
3. We will be working with people who are inexperienced in this area. Therefore, it appears wise to begin with a system that can be taken over rather quickly and then developed further as new hardware and instructional material become available. Beginning with teletype units and adding audio and visual capabilities later appears to be the most sensible route to follow.
4. The availability of experienced men such as Dr. Patrick Suppes, Dr. Richard Atkinson, Dr. Duncan Hansen and Mr. Max Jerman as consultants to our project is extremely significant. These men will be available through RCA.
5. The material that Dr. Suppes and his assistants have developed at Stanford will be available immediately via the RCA configuration. This appears to be most vital to the project.
6. Considering RCA's close ties with Harcourt Brace and Jovanovich, Inc., the type of corporate support, the instructional materials available coupled with the promised assistance in planning and training personnel throughout the project; it is my strong recommendation that we award the contract, after proper negotiations, to RCA.

Instructional Innovation Must Begin With The Teacher Or It Will
End Outside The Classroom Door.

WHO WILL DEVELOP THE CAI PROGRAMS?

A basic premise of the INDICOM Project is that perceptive classroom teachers who are in daily contact with youngsters are in the best position to develop CAI. The initial project design made provision for hiring outstanding classroom teachers to develop CAI materials that would represent an approach toward a K-12 continuous progress multimediated curriculum.

Accordingly, 40 of the district's best teachers were selected for the INDICOM design team staff. INDICOM core staff members appeared at staff meetings in each of the district's 34 schools to encourage Waterford teachers to apply for the project. More than 100 applications were received and each of these applicants was interviewed personally.

The final selection of the initial group of INDICOM teacher-authors was made on the basis of their subject matter expertise in reference to project needs, their reputation as fine teachers and their enthusiasm for innovation. The following design team staff was assembled:



Among the 40 design team members who have developed over 1,200 lessons in a variety of subject areas are (from left) Verne Vackaro, James Dieck and Robert Hutchinson.

DESIGN TEAM MEMBERS

MATHEMATICS

Dennis Bila
William Cole

Charles Johnson
Bob Mitchell

Alfred Monetta
Charles Schmidt
Vi White

SCIENCE

Robert Bass
Barbara Drake

Howard Heitzeg
Roger Johnson

Wayne Johnson
Donald Maxwell
Charles Welsh

BUSINESS

Janet Bachelor

Joan Boose

John Shupe

LANGUAGE ARTS

Linda Barth
Robert Kaminskis

Sue Shipley
Mary Jo Smith

Richard Williams
Ann Winston
William Yost

SPELLING AND READING

Mary Beth Davison

William Miller

Martha Wheeler

SOCIAL STUDIES

James Dieck

Robert Hutchinson

Vern Vackaro

CLASSROOM MANAGEMENT

John Dumas

Ben Platnik

ECONOMICS

Raymond Grambau

Richard Jenrow

John Sommers

MUSIC

Melvin Rookus

LIBRARY

Lucy Ainsley

TRAINING CLASSROOM TEACHERS AS AUTHORS OF CAI

In its first two years, the INDICOM Project trained 49 full-time teachers as CAI authors. The more than 1200 lessons these teachers have written range in intricacy from simple demonstration units to semester length programs of tri-leveled tutorial instruction. Some incorporate gaming and inquiry techniques and depend on the audio and graphic enhancements of the I-71 system for portions of the instruction.

Because Computer Assisted Instruction existed more in theory than in practice, the training program that brought the INDICOM authors to this relatively high level of sophistication in CAI was necessarily developed empirically (for purists-through trial and error). However, at this point, the INDICOM Project probably has had more experience training CAI authors than any other organization.

TRAINING OBJECTIVES

As a result of the training program, INDICOM curriculum designers are able to write, use and evaluate instructional materials which facilitate the individualization of instruction. These materials must permit the realization of agreed upon behavioral objectives and make the most efficient use of the RCA Instructional 71 Computer System and any other appropriate instructional media.

Accomplishment of these objectives requires that the designers acquire a sound knowledge of learning theory; an overview of CAI which includes the state of the art, its potentialities, advantages and limitations; an acquaintance with the literature of CAI and encoding knowledge of appropriate computer languages.

THE TRAINING PROGRAM

The INDICOM training program began and continued as a series of workshops conducted by the INDICOM staff and selected consultants. The teachers, who were selected for their subject matter knowledge as well as their expertise in the classroom, worked in design teams according to academic interests. Time and ample materials were provided for independent study and the teams were encouraged to consult subject matter experts of their own choosing. The core staff continued to meet with the individual teams as required for consultation and direction.

Considered first in the training program were the techniques of curriculum construction. Following an orientation to the systems approach and its application to education, the teams were trained to write behavioral objectives as the initial step in curriculum design. (Behavioral objectives tell what a learner will be able to do after he has completed a prescribed course of instruction. Well-stated objectives describe under what circumstances and to what degree of perfection the desired behavior will occur).

Implicit in the systems approach to curriculum construction is the assumption that subject matter can be taught most efficiently by first determining the ultimate learning goal or the terminal objective and then planning a system of intermediate instructional objectives incorporating the prerequisite learning accomplishments that lead to the terminal objective. An effective instructional system avoids teaching what is already known. At the same time, it should not hold the assumption that the learner has attained prerequisite skills, but rather must assess the student to determine his level of accomplishment.

Criterion tests to determine when an objective has been accomplished and tests that assess a student's entry level are prerequisites to planning an effective instructional system. Therefore, having learned to develop objectives for the instructional system, the next consideration was the construction of pre and posttests to assess the learner's accomplishments. With objectives stated and pre and posttests written, there were still a number of other decisions the teachers had to learn to make before they could begin to write specific lessons for computer presentation:

1. Should the program attempt to teach basic concepts or should the program provide reinforcement, drill and review of concepts taught by the teachers (drill and practice or tutorial)?
2. In terms of instructional programming, what strategies are desirable for the instructional task? What strategies are possible on the I/71 System? Possibilities to consider included:
 - a. One track linear routines
 - b. One track linear routines with remedial and advancement loops.

- c. Multi-level linear strategies
 - d. True branching programs
 - e. Inquiry or dialogue strategies
 - f. Or some combination of these
3. Will audio or visual enhancements be needed?
 4. How will the program fit within existing curriculum?
 5. Should the program be self-contained or require classroom reinforcement?
 6. What kind of supplementary materials will be required and what is available?

Of course, in order to make these decisions, the teachers had to be trained in instructional programming strategies, the capabilities and constraints of the I/71 system and encoding procedures.

The principles of designing paper and pencil programmed instruction were the basis of the training in instructional programming strategies. To the usual considerations of writing programmed instruction (individual frame construction, sequence of frames, kinds of responses required etc.) were added the concerns of making most efficient use of the computer system in terms of storage capacity, computer response time, time-out for the student, lesson length and student and teacher feedback.

While it is not necessary that curriculum authors become sophisticated computer programmers, it is imperative that they become acquainted with the capabilities and constraints of the computer system hardware and software. They must learn the kinds of strategies the computer can handle, the trade-offs involved in complicated procedural programs and other factors that affect computer efficiency.

Having them take lessons at the student terminal is the most effective means of impressing the prospective CAI authors with the necessity of rapid systems response as well as the desirability of providing ample student involvement by avoiding excess verbiage. It is also most helpful for the prospective programmers to have the opportunity to test their lessons on

line as soon as possible. Unfortunately the INDICOM authors were writing for a system not yet in existence. They did have some opportunity, however, to write and test lessons on the RCA I/70 System.

When the design teams were given the go-ahead on designing procedural programs for handling their curriculum materials and when the teams were satisfied with their design, consultation with the INDICOM Instructional Technologist served to explain the full implications of the desired procedure. In some cases, the system simply could not handle what the teams wanted. In most cases, a compromise was reached so that the basic design was that of curriculum authors with some variation to achieve maximum efficiency on the system.

Mnemonic codes were then written for these procedures. In working with these codes, the design teams began to understand better the function of the hardware and software.

SIMPLE

A very versatile author language called SIMPLE was developed by INDICOM Instructional Technologist, Mr. Al Pavlish, with assistance of the RCA staff, particularly Mr. Gary Mason. It became apparent early in the project that it would be necessary to develop a language that curriculum authors could use to program their material into the computer.

Due to the large number of writing teams, a variety of techniques were developed to handle the curriculum. So, rather than write a program for each design team, a series of macros was designed and implemented in a generalized program called SIMPLE (Student Instructional Macro Program Language Environment).

Input to the design came from two major sources: (1) requirements and wishes of the authors, (2) an extensive study of other existing CAI languages.

The actual program was written in the RCA BASIC Assembly language. The initial plans were to write this program in ISL-2. But, since the language itself was in a developmental state at this time and, because the date for its availability was not as secure as it could be, to develop all other curriculum contingent on its delivery was not reasonable.

The language is quite flexible. It has several forms of branching and lesson scheduling techniques. It can branch on a right or wrong answer, criteria achieved or not achieved, or on selected words or answers. It has the capability of analyzing student answers phonetically and it will accept multiple choice type answers in any order and also scan multi-word answers for key words.

It will allow for several correct or incorrect answers to a single question and perform a variable amount of branching as a result of the student input.

The language is so designed that entering the curriculum is done using the terminal. Mnemonic codes were developed to make the language easy to learn. An example is ANS for Answer, BIC for Branch if Criteria is made and CCM for Continuous Criteria Mode which indicates that a predetermined consecutive number of answers must be correct for the student to go on.

SIMPLE has an auxiliary program called the DataTranslator that is used in conjunction with it. This program, DATTRN, is essentially a compiler which is run against the curriculum data prior to the execution of the lesson with SIMPLE. DATTRN checks the lesson for coding errors, syntax errors and converts the three character codes such as ANS to a single character code. This conversion makes the execution of the program much faster.

A few of the distinct features of the language are:

1. mnemonic codes
2. easy to learn
3. has an editing feature
4. capabilities to handle curriculum designed for nearly any other CAI system
5. author control of lessons sequence or teacher control of lesson sequence for a given student
6. non-professionals can load and/or edit curriculum coding

SIMPLE has the capabilities needed in any of the original instructional strategies planned by the design teams. Unfortunately SIMPLE could not be developed nor implemented until the I-71 system was installed in December of 1969, after most of the design team work was finished. Though several of the design teams working in the summer of 1970 were able to add lessons using the more sophisticated strategies made possible by SIMPLE, many of the original strategies had to be redesigned to fit within the constraints of a less versatile language.

We Tend To Consistently Underestimate The Students' Ability And Adaptability

THE FIRST INDICOM CAI LABORATORY

In October, 1968, 360 Riverside elementary school youngsters in the second through sixth grade began taking daily CAI mathematics drill and practice lessons. Seated at 32 teletype terminals, the youngsters received the lessons via remote hook up from an RCA Spectra 70 computer in Palo Alto, California. Commercially - developed curricula was utilized at the start since curriculum materials designed by Waterford teachers were not yet ready for presentation under computer control.

During the second semester another 75 fifth graders began receiving language arts lessons on the same system. A group of 25 high school youngsters identified as potential drop-outs also began mathematics instruction in the second semester as part of a special basic skills class. INDICOM curriculum designers and Riverside teachers were also able to use the terminals.

That all of this activity took place during three hours' daily running time is an indication of the efficiency of the initial INDICOM CAI Laboratory.

The original INDICOM laboratory staffing included the instructional technologist, a librarian and a clerk-secretary. The smooth implementation of CAI at the Riverside Laboratory was the result of meticulous planning by INDICOM personnel in cooperation with the Riverside staff. The goals of the planners were to assure maximum use of the limited computer time with a minimum of disruption to the regular Riverside schedule.

To make provision for the scheduling of music and gym class, recess, etc., a rotating class schedule was instituted at the lab. Hall passes were used to relay students to the CAI lab. The terminals never sat idle, yet students were not required to waste time waiting for their turns at the terminals.

To prepare the Riverside teachers to take full advantage of the opportunities afforded by the CAI lessons for individualizing mathematics instruction in the classroom, a series of workshops was conducted.

The L.W. Singer (now Random House) mathematics CAI program is divided into five years (grades 2 through 6) of instruction, and each year is divided into 22 concept blocks. Each concept block contains 7 days' instruction on five levels of difficulty; first and seventh days are pre and posttests. The pretest determines the level of difficulty the student will receive on the first lesson in the concept block. The student's performance on the lessons determines the level of subsequent lessons. The lessons are designed to reinforce classroom instruction and are sequenced by the teacher to follow his lesson plans. The teachers, therefore, had to become familiar with the design of the program and the content of the concept blocks.

Standard achievement tests were used to determine the grade level of the instruction for each child. Later in the year, a few children were found to need a different year of instruction and were enrolled at the proper grade level.

Orientation programs and materials were also planned for the students. However, one error in judgment appears to be that the staff consistently underestimated the ability of the youngsters, both to adapt to using a teletype keyboard and to handle rather complex concepts presented in a systematic manner. The Riverside youngsters became comfortable with the teletype terminals in less than twenty minutes. Even first graders and a few kindergarten youngsters were eventually able to use the terminals.

Perhaps the most rewarding single week of the Riverside operation was a trial run for deaf children. The children ranged in age from 7 to 11, but their enthusiasm was uniform. They adapted as readily to the teletype as any other children, but their joyful response to the experience surpassed any others. A lack of hearing is no handicap in the teletype operation.

The Riverside teachers, too, are "CAI boosters," although they will report in no uncertain terms that CAI has not lessened their work load. On the contrary, they found that providing classroom instruction to suit the differences among students, requires a great deal of effort. However, they have found that being relieved from the chores of drilling, assigning homework and much paper-checking has given them more time for creative aspects of teaching.



Extensive evaluation indicates that the achievement of elementary students in mathematics and language arts can be extended and accelerated by CAI. In addition, student attitude toward these subject areas improves when CAI is utilized (See Pages 24 and 58).



In addition to capturing the interest of students and teachers, CAI has also maintained a strong following among parents and administrators. Pictured here examining CAI performance data are (from left) Roy Alexander, Assistant Superintendent (Instruction K-12); Mrs. Robert Slack, mother of Riverside second grader John Slack; and Charles Welsh, principal of Riverside School. Daily feedback on student progress is readily available, not only to the student and teacher, but also to the concerned parent. (See page 14.)

Mr. Gerry McLeod, a fifth grade teacher at Riverside School, made this observation on the CAI operation four months after it was implemented:

"When first notified that the INDICOM CAI Laboratory would be located at our school, the teachers at Riverside were told it would involve a great deal more work. The staff's first reaction last fall to the 32 terminal operation was one of bewilderment. It didn't take long, however, to be at ease in the lab. After we began to get the feel of our new schedule of time, lessons and drill, we began to look at the material we were receiving. Now those of us that have been "on" since October can even interpret the print outs and determine what we've done wrong or what we can do better.

Recently we began some work on the terminals with fractions. I was immediately made aware of that fact that I had completely missed most of the class in teaching a very basic concept. Without the machines, I'm sure we would have sailed right on without having noticed what we hadn't learned. This is a good example of how we can pick up the weak areas in our teaching program. The "instant answer drill" is invaluable. Another one of the advantages of INDICOM is the motivation it provides for the children in arithmetic and grammar. Can you imagine your entire class intensely concentrating on what is very mundane drill work for as long as 30 minutes each day? At first we wondered if the novelty of the terminal would wear off. But we've been on nearly every day since October and the boys and girls, if anything, are more interested than they were at first.

To sum up, I believe it would be fair to say that the consensus of the Riverside staff has progressed from skepticism, to bewilderment, to questioning, to application (our present status). I'm sure that complete satisfaction is just around the corner and I can feel amazement in the future when the potential of what we have here develops and grows."

Mr. McLeod's prediction about staff satisfaction proved accurate as the CAI operation progressed and erased doubts that existed at the outset.

While the teachers were somewhat hesitant in accepting CAI as a fact of educational life, pupils at Riverside and their parents were impressed and won over almost immediately. The children,

of course, were fascinated by the equipment but even the second graders seemed to appreciate the special learning opportunity that had been given to them.

A comment by second grader, Julie Simms, is quite typical of the remarks of the Riverside pupils. Julie said:

"Computers help me learn and they teach you how to do multiplication but most of all I think they are the best things in the whole world that teach children and they are great. I like them very much. The End."

Parent reaction is summed up in the following random selection of remarks:

"We go over the print-out at home and both children could explain and understand their error."

"I find the papers much easier to understand than regular papers with only answers on them."

"My son in fourth grade has always had difficulty with math, but his attitude seems better now."

"The girl seemed to be bothered by her mistakes and could hardly wait for the next lesson."

"What is good for one child is not necessarily good for another. The child should be taken as an individual to see if the computer is good for that child."

"If my children could be made as eager to learn English, science, and other subjects, educating them would be a breeze."

"I feel strongly that INDICOM is an extremely valuable educational tool. It assures that no facet of a course of study will be overlooked or poorly presented."

"The percentage scores should be left off. It doesn't upset the child but too many parents expect 100% all of the time and harass their children on this point."

"I found it has strengthened the interest in math. It is quite a change from the dull methods."

"At least there are no personality conflicts between child and teacher in the terminal room."

"I have noticed my third grader's ability to add etc., much more rapidly than my fifth and sixth graders when they were in the third grade, and feel that INDICOM has done this for him."

"Besides doing the answers, they have to think. I wish you'd get the bugs out of it."

"I like the step by step progress designed especially for my child without allowing a mistake to stand without correction."

"Our child would not miss school for fear of not being able to use the computer."

"It keeps the teachers on their toes. If a teacher doesn't get the subject across to the children it will be apparent."

"I think this gives the quiet ones a chance to deal with their problems."

Riverside Principal, Mr. Charles Welsh, sees two very distinct advantages provided by CAI:

"The program has forced our teachers to really look at the individual child and has made the teacher more aware of each child's unique needs. It has also provided both teacher and child with more time for creative efforts because the work with the computer system is like monitored homework. It takes care of a lot of the drill."

Perhaps a reflection of the greater opportunity for creativity allowed by CAI was the request by a group of Riverside fifth graders to be taught how to code and load lessons. Thanks to the easily learned SIMPLE language, they very quickly accomplished what they set out to do. The word spread and before long the entire student body of the upper three grades became inspired with the creative urge. They wrote lessons in geography, science, spelling and reading. Usually the finished

lesson was the product of a committee composed of lesson-writers and lesson-loaders.

The following is an example of the lessons created by the Riverside "Junior Curriculum Authors":

- 10 DSP THE FOLLOWING WORDS ARE SCRAMBLED. UNSCRAMBLE THEM
- 20 DSP BSUINSES
- 30 ANS BUSINESS
- 40 DSP OMNKEY
- 50 ANS MONKEY
- 60 DSP AOVEB
- 70 ANS ABOVE
- 80 DSP AMOGN
- 90 ANS AMONG
- 100 DSP BUYS
- 110 ANS BUSY
- 120 DSP THE FOLLOWING WORDS ARE MISSPELLED
- 130 DSP SPELL THEM CORRECTLY
- 140 DSP AVARAGE
- 150 ANS AVERAGE
- 160 DSP PALASE
- 170 ANS PALACE
- 180 DSP CHAKE
- 190 ANS CHALK
- 200 DSP CHOCKLATE
- 210 ANS CHOCOLATE
- 220 DSP LOVINGLLY
- 230 ANS LOVINGLY
- 240 DSP BUSSILY
- 250 ANS BUSILY
- 260 DSP WONDEROS
- 270 ANS WONDROUS
- 280 DSP BURIEL
- 290 ANS BURIEL
- 300 DSP IN THE WORD ONE LETTER HAS BEEN LEFT OUT, TYPE THE
- 310 DSP LETTER, THESE LETTERS ARE LEFT OUT: M L G V D K R
- 320 DSP CLI ATE
- 330 ANS M
- 340 DSP COLLE E
- 350 ANS G
- 360 DSP ETTUCE
- 370 ANS L
- 380 DSP LO ED
- 390 ANS V
- 400 DSP SA T
- 410 ANS L

420 DSP PAC AGE
430 ANS K
440 DSP WON ER
450 ANS D
460 DSP BURIED
470 ANS R
480 EOF
READY-
0290 ANS BURIAL
/SSAVE

INSTALLATION OF THE I-71 SYSTEM

In December, 1969, the long-awaited RCA Instructional I-71 System finally arrived and was installed in the Mott High School Media Center. Sixteen of the student teletype terminals were moved from Riverside to the prepared Mott site, and visual display screens and listening gear were added to all 32 terminals.

The disk packs to run the Random House CAI Mathematics and the Harcourt Brace and Jovanovich CAI Language Arts programs were also delivered. The promised ISL-II language software was not. The installation and debugging process seemed chaotic but actually was beset by no more problems than should be anticipated when working with such complex precision equipment.

The audio-visual units were planned to enhance the curriculum offerings of the computer-terminal arrangement. Besides the teletype communication between the computer and student via the terminal, there would be supplementary lesson material by audio or graphics, or both. The Visual Display Unit (VDS) is basically a rear screen projection unit housing an Eastman Kodak Ektagraphic MFS-8 projector, modified for computer controlled operation. Under control of the I-71 System, the VDS is capable of showing any of approximately 3,600 frames.

When a lesson programed in the I-71 requires visual materials, the screen lights up and a teletype message instructs the student to type the number that appears on the screen. This number is a location code that cues the computer to move the projector forward or backward. The visuals themselves are coded by block and frame numbers. All visuals used on the VDS are prepared by INDICOM.

Drawing from commonly used words and specialty words from their own subject areas, the INDICOM design teams formulated a list of nearly 600 words for the I-71 Audio Vocabulary. The words in digital form are stored on the audio disk of the RCA 1600 computer for use when needed. As one of the three computers in the I-71 System, the 1600's only purpose is the presentation of audio messages to the student. This use of digitized audio permits the required word or words to be found, arranged and transmitted to the student within one second. Eight different messages can be handled simultaneously.

The Riverside operation was discontinued for three weeks while the I-71 installation and transfer of terminals took place and the efficiency of the administration was resumed. By the end of January, 1970 both the Riverside and Mott labs were functioning smoothly.

Absence of the ISL-II software delayed even further the implementation, testing and revision of the INDICOM curriculum materials. Procedure programs and an author language had to be written in Basic Assembly Language. The INDICOM Instructional Technologist and the RCA support personnel were able to accomplish this task in a remarkably short time, as mentioned previously in this report.

The procedural program to handle the INDICOM Communications and Mathematic Skills Program (CMSP) was written in a few weeks. Programs were also written to handle administrative and data processing procedures that were not originally planned for the I-70 system.

Plans for running CAI classes for high school students during the semester also suffered a setback as a result of the software delay. CMSP classes had been scheduled and were conducted. The mathematics teachers used single concept student management books they had developed on a variety of auto instructional materials in addition to portions of the Random House mathematics materials. These classes have been very successful in terms of student enthusiasm and their enrollment has nearly tripled.

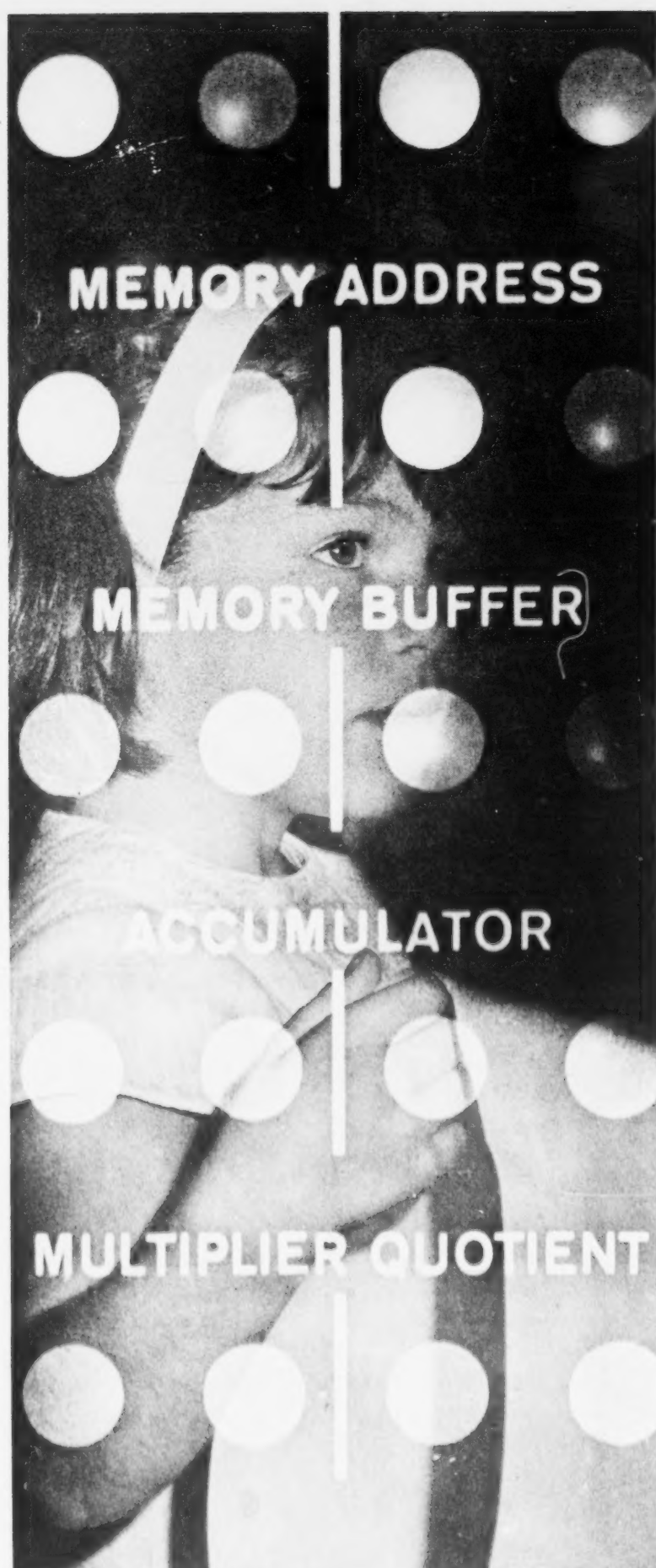
The CMSP language arts programs did not meet with similar success. Anxious for the promised CAI lessons, the students were permitted to take demonstration lessons in the Harcourt Brace and Jovanovich program. These were judged "too elementary" by some of the high school students. They eventually did get to take the first seven units of INDICOM materials, but the lessons were not administered as intended, according to student needs. There were also bugs in the leveling procedure within the units that prevented an accurate assessment of their usefulness. A summer school junior high class was more successful.

The Mott run was also more successful for special education and evening adult basic education students who were able to use the drill and practice programs more profitably. Though

the adult classes were too small to claim conclusive proof, the gains exhibited by the students were very nearly sensational. The mean gain was 2.5 grades in three months.

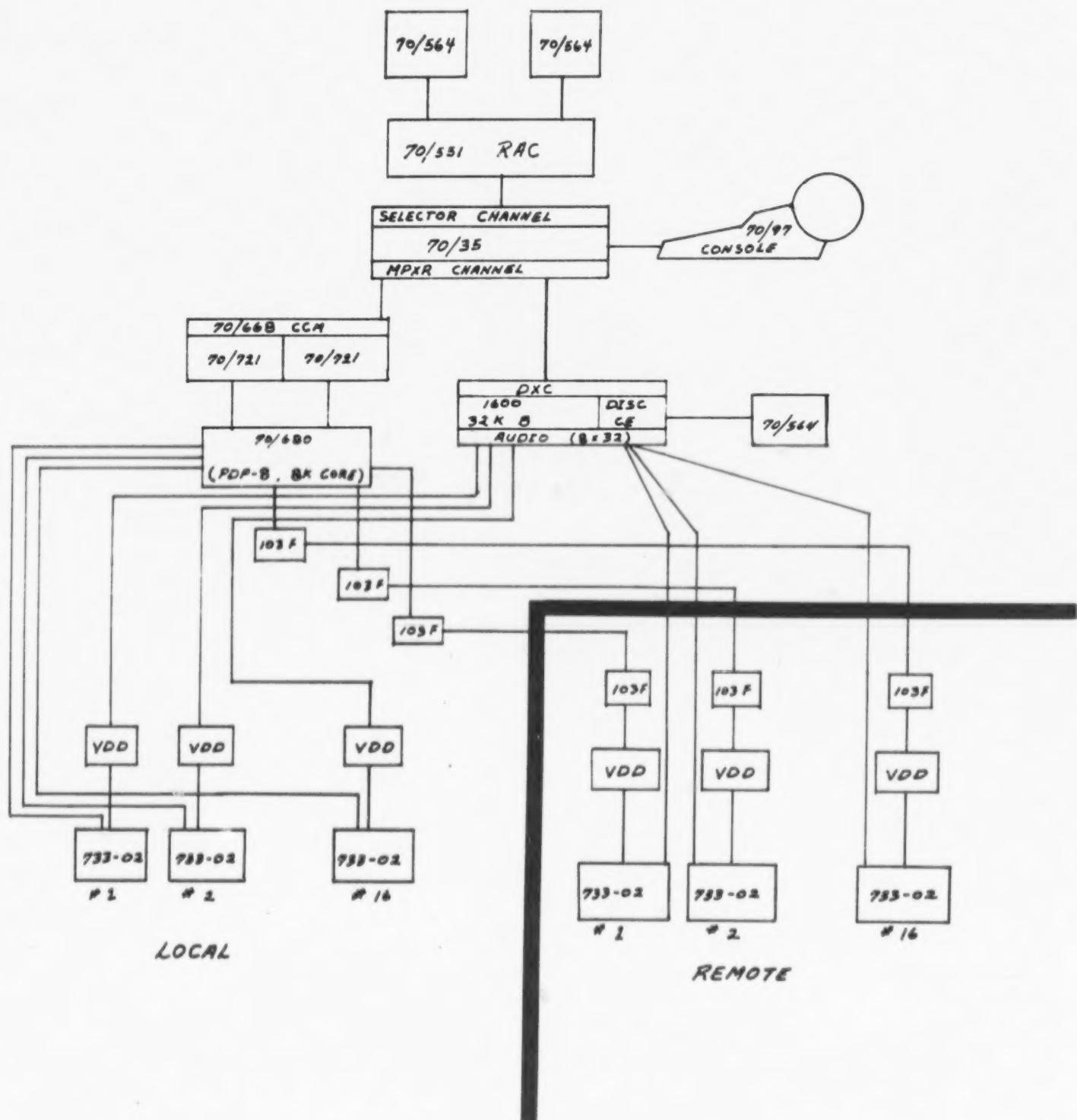
A very profitable discovery, both in terms of educational gain and operations costs, was that high school students can do much of the work of coding and loading that had been allocated in the original budget to highly paid technicians. Much of the curriculum coding and all of the loading of the INDICOM curriculum materials has been done by students. Students have also prepared visual materials that accompany some of the INDICOM programs.

The intricacies of the I-71 system captivated the imaginations of Mott students and resulted in what amounts to an extra-curricular class in several programming languages including Basic and Cobol.



Acceptance of the RCA Instructional -71 System awaits final testing of the digitized audio. The computer controlled graphics have presented many operational problems and are unacceptable. INDICOM and RCA are currently negotiating a viable substitution for the graphic components. However, the basic system, including the teletype terminals, is performing satisfactorily.

WATERFORD CAI SYSTEM



INSTRUCTIONAL-71 COMPUTER SYSTEM COMPONENTS

Central Processor 70/35 - It is a powerful solid-state, general purpose, digital processor. The 70/35 is a diad organized, variable format processor consisting of main memory; a read-only memory with a memory cycle of 1.44 microseconds; and a read-only control memory with a memory cycle of 480 nano-seconds. The CPU has a storage capacity of 65K.

Printer 70/242 - The printer prints output documents at a rate up to 625 lines per minute. A single data line contains 132 print positions.

Line Concentrator 70/680 - It is a small scale computer with a memory size of 8K. It communicates between the CCM and all individual terminals.

Random Access Controller 70/551 - The RAC operates all random-access devices such as disks and drums in the spectra 70 series. The controller maintains a comprehensive accuracy check on the data being read and written.

Communication Controller Multichannel 70/688 - The primary function of the CCM is to notify the processor of the recognition of specific characters and character sequences having a control significance for a particular communication. The core memory within the CCM provides basic communication system status information and operating rules. It consists of a 512 - 18 word memory.

Console 70/97 - It is a free-standing, self-contained unit which provides sufficient control to enable system operation in conjunction with operating system program.

Card Punch 70/234 - It is an 80 column row oriented card punch and is capable of punching and checking cards at the rate of 100 cards per minute. A read after punch feature is provided to give a whole account accuracy check on the punch data.

Card Reader 70/237 - The card reader reads standard 80 column punched cards at rates up to 1,435 cards per minute. Cards are read column-by-column and maximum speeds can be obtained on a demand basis.

1600 System - This audio system is an independent computer under the control of the 70/35 computer. It consists of the RCA 1600 computer and one disk drive. The audio vocabulary is stored on a disk which has a maximum vocabulary of about 2,000 words.

Visual Display Stations - The VDS is basically a rear screen projection unit modified for computer controlled operation. It is capable of finding and showing any of approximately 3,600 frames.

EVALUATION

Several conclusions have been drawn from the evaluation of the INDICOM Project to date. In most CAI classes, significantly greater achievement appeared than in non-CAI classes and students' attitudes toward computer and computer-augmented curriculum changed in a positive direction. Parents enthusiastically accepted CAI as part of their youngsters' schooling. Teachers feel CAI has freed them from some routine classroom chores and made more time available for creative teaching. Design team authors feel they are able to write good CAI curriculum, and that the systems approach to curriculum development has acted as a catalyst for change in their own classrooms.

The INDICOM Project published an 88-page Evaluation Monograph in February, 1970 in which all project objectives were presented and evaluated. Further evaluation occurred since the Monograph was published and an update of findings as of July 31, 1970 is reported on the following pages.

INDICOM PROJECT
EVALUATION SUMMARY
July 31, 1970

OBJECTIVE NUMBER ONE:

To establish specific behavioral objectives for each content area prepared for computer presentation.

Results

Mrs. Ruth Penny, INDICOM Curriculum Editor, has been coordinating the curriculum and has teachers' manuals with objectives for almost every area developed by design teams. A curriculum file is being kept in her office, but the most up to date one is at the Mott CAI Lab. Teachers' manuals in mathematics, language arts, reading and spelling and a successful pilot feasibility study in mathematics were finished for Adult Basic Education. All INDICOM curriculum needs to be tested more thoroughly than has presently been done.

OBJECTIVE NUMBER TWO:

To establish efficient and effective training programs for personnel involved in the INDICOM Project.

Results

The words "efficient" and "effective" are ambiguous terms depending upon who judges them. In this evaluation, it has been decided to define them as they were perceived in the eyes and minds of the receivers of the training program, i.e., whether or not the design team members felt their training was efficient and effective. The training and results are reported in Evaluation Monograph No. 1 and do not need to be updated at the present time unless additional comments can be obtained from design team members.

OBJECTIVE NUMBER THREE:

To investigate the growth made by participating students in the subject matter presented at the computer terminals.

Results

This objective has been a major responsibility of the Research and Mathematics Specialist, and results through the Summer 1969 are reported in Evaluation Monograph No. 1. At that time most results from CAI elementary school mathematics and English achievement, a CMSP Mathematics pilot study, attitudes of students toward CAI and subject matter presented by CAI, parent opinions, and small studies with special students were very encouraging. Following are summaries of the 1969-70 investigations:

A. Elementary School Mathematics

The standardized pre and posttests administered to Riverside School students in grades two through six were changed in 1969-1970 to more accurately reflect the intent of the CAI mathematics drill and practice material. The results produced statistically significant differences in every grade at $P < .05$ in favor of CAI over non-CAI. Further analysis revealed that the upper half in mental ability showed at least twice as much gain as expected and accounted for the differences. The lower mental ability students made a normal gain. The results from this study imply that short drills and reviews geared to an individual's needs and success accomplish at least as much as traditional instruction for the less able student and definitely accelerate the more able student. Whether non-CAI methods could do this and put no more burden on the teacher is not presently known. Whether revision of the curriculum data base, classroom instruction, or something else will help the less able needs to be further investigated.

B. Elementary School English

Harcourt Brace Jovanovich, Inc., replicated its pilot study of Spring 1969 during the full 1969-1970 school year with selected fourth, fifth and sixth grades. Dr. Norman Fitzgibbon has sent the testing results to us, and these have been reported to the schools and teachers, with stick-on labels being made of all test results for inclusion in permanent student records. However, statistical analysis by HBJ is not completed at this date.

Dr. Fitzgibbon is analyzing our data for us with the non-parametric Kruskal-Wallis one way analysis of variance, then re-analyzing with all the students in the country using CAI Elementary English.

C. Attitudes of Riverside Students

The study of attitudes over the school year 1968-1969 produced significant changes in a positive direction of attitudes toward computer, computer assisted instruction and subject matter presented via CAI. The 1969-1970 replication of the attitude scale indicated that the highly positive attitudes achieved the previous year were maintained in all grades but fifth, where attitudes changed in a negative direction. Further analysis revealed that one class of these fifth graders accounted for most of the change. This class had a much higher IQ than the others, indicating that the brighter student, even though he achieves more does not like computer "down time" or "wait time" such as was experienced during a large portion of the INDICOM Project's third year.

D. CMSP - Language Arts

The CMSP-LA classes at Mott High School during the second semester 1969-1970 did not furnish INDICOM with enough data to effectively analyze this curriculum. The reasons for this were that hardware and software were being debugged and curriculum was being tested only for the first time to find errors in the data base or in loading. Nevertheless, the General Diagnostic Test was administered as pre and posttests to about 140 students and analyzed by Oakland Schools PACER program. This data needs to be perused and one good test should emerge to diagnose and measure achievement of the CMSP-LA materials. Mr. Dan Hogan, former Mott principal, has access to MSU's computer to run multivariate analysis of covariance on the experimental and control classes to see if any effect of CAI has been produced. Additional testing needs to be done on CMSP-LA.

E. Mathematics - CMSP

Even though INDICOM's CMSP mathematics materials were only partially loaded and partially tested during Spring 1970,

commercial CAI mathematics and INDICOM's student routing booklets were available to CMSP-Mathematics. A thorough analysis of about 80 students' achievements and attitudes will result in the dissertation of Mr. William Cole, who designed curriculum for INDICOM. Preliminary analysis of covariance indicates statistically significant gains in all areas treated by CAI, including attitudes toward mathematics. Multiple linear regression equations were generated to predict posttest scores on the CMSP Mathematics Survey Test. The best combination of predictors were the Mathematics Survey pretest, SAT Concepts pretest, first semester attendance, junior high mathematics average, and the Education Scale pretest.

Encouraging pilot tests of the CMSP Mathematics units on fractions, decimals, percents, measurement, and estimation indicate that even more significant achievement may result in the future.

F. Other

1. Harcourt Brace Jovanovich Remedial Reading was used to some extent during 1969-1970, but not effectively enough to research and evaluate.
2. Some deaf, hard of hearing, and mentally handicapped students were placed on the terminals for short periods of time, and the unobtrusive results appeared encouraging.
3. Eight Adult Basic Education students in ten 1 1/2 hour sessions gained an average of three years in mathematics achievement using computer assisted instruction.
4. Summer School CAI programs were conducted at Riverside for grades two through six in mathematics and language arts. At Mott, CAI classes in mathematics, language arts, and remedial reading were offered. Deaf, hard of hearing, and Learning Improvement Center students had short daily access to CAI at Riverside, also. No formal research was done on the summer school programs, but INDICOM Librarian, Mrs. Lucy Ainslev has submitted a report describing these and recording student, parent and teacher reactions.

OBJECTIVE NUMBER FOUR:

To investigate whether or not computers do, in fact, assist the teachers and relieve them of routine tasks to conduct more creative activities.

Results

An opinionnaire was administered to all professional staff of Waterford Schools in September, 1967 and again in June, 1970. Results indicate that the staff initially possessed a positive attitude and feeling toward INDICOM and CAI. The posttest indicates that positive feelings have not only been maintained but the responses to most questions indicate a gain. Many staff members have developed definite ideas and feelings, as indicated by the changes from "Undecided" responses on the pretest to either "Yes" or "No" responses on the posttest. Teachers felt that computers were a partial answer to education, not the answer; and, although the computer does free the teacher to continually individualize instruction and to work with small groups as well as with the individual student, CAI does not mean less work for classroom teachers.

Comments from teachers and principals have been collected and reported in Evaluation Monograph No. 1. Revision of reporting procedures, use of printouts, and instructional techniques for CAI are continually occurring.

OBJECTIVE NUMBER FIVE:

To determine if an instructional materials center is conducive to individualized instruction.

Results

Objective Five appeared in the original INDICOM proposal and has only cursorily been a part of the Project since it has been in the Waterford School District. Dr. Peggy Miller of the State Department has given the Project permission to abandon this objective as it is almost impossible to measure at this time.

OBJECTIVE NUMBER SIX:

To point the direction toward defining the role of the student and teacher in a program of computer assisted instruction.

Results

Computer assisted instruction is still in its infancy, and there is a great deal more work to be done to make it more functional and effective. CAI can help provide each student with a quality education, but it is not enough in its present state. Schools eventually may, when better CAI programs exist, be organized around a laboratory, seminar program where the teacher introduces an idea, students work at computer terminals, and the teacher uses reports to help individual students. Teachers would have reliable, current data on each student rather than being handicapped as presently by yearly tests, some daily work, and experience. Diagnosis and prescription for each student will make teaching a real profession.

Teachers have had to state specific objectives for curriculum presented by CAI, causing them to rethink what they do in the classroom. On the other hand, reduced resources of the INDICOM Project have not allowed the Project to be as effective within the school system as it had anticipated. This conclusion can be documented by the staff opinionnaire as well as comments from teachers and principals.

Positively directed changes in attitudes of students involved in CAI have been effected in most instances. Whether a long term effect will remain is a question for further research. Comments from students and teachers seem to indicate that CAI changes the competition for success in subject areas from between individuals to within an individual - he competes with himself on a daily basis. If individualized instruction is a goal of education, then this facet of competition may be a giant step. Hopefully, the roles of education and students in CAI will evolve from an eclectic-pragmatic approach, and not be predefined before the capacity of CAI can be fully realized.

OBJECTIVE NUMBER SEVEN:

To develop an efficient and effective dissemination program for the results of the INDICOM Project.

Results

Again, the definition of the terms "efficient" and "effective" will be determined in the minds of the receivers of the dissemination activities. Newspaper and magazine articles, Project visitations, reports to governmental agencies, presentations to many groups, and co-sponsorship of a national conference have resulted in many comments and testimonial letters from many sources. This may be documented from the INDICOM files, but the Project itself also feels that dissemination has been efficient and effective.

Conclusions

The major portion of evaluation activities took place during 1969-1970, and the results were highly encouraging. INDICOM has proven itself a viable project and has demonstrated that CAI can produce significant differences. However, even though it has been a successful demonstration center in Michigan for CAI, it has not achieved the other goal for which it was initially funded: "Can teachers within a school system develop effective curriculum for computer presentation?" With delays in hardware and computer software, reductions in funding and personnel, and other reasons, the research and evaluation of INDICOM developed curriculum is just now in the initial stages. It would be a giant step backwards for computer assisted instruction to not pursue this development.

The Project Has Had Both An In-district
And A Far-reaching Influence on Education

EFFECTS OF INDICOM

INDICOM, of course, could not exist without the aid and assistance of the Waterford School District. On the other hand, it has been helpful to the district as a catalytic agent in curriculum development. The staff of INDICOM has participated in various phases of curriculum development both on a formal and informal basis.

Over 100 teachers participated in workshops aimed at developing a format conducive to individualizing instruction. Members of the INDICOM staff participated in the local Programed Learning Committee, Grade School Planning Committee and the Junior High Planning Committee. They also aided in curriculum development for Mott High School.

On an informal basis, the teachers who make up the design teams have shared their enthusiasm and helped to disseminate information about the innovative educational methods and technology being explored by INDICOM. This has led to many inquiries and requests for information and help from interested people throughout the district.

The INDICOM staff recognized the critical need to be considered as a natural part of the Waterford School District team. INDICOM has made clear its intention to function as an integral part of the school district and has taken pains to maintain unobstructed channels of communication with other agencies within the district itself. INDICOM has, perhaps indirectly, aided in establishing new channels of communication and has prompted new dialogue and cooperation among important people and groups within the district. Every move of the staff in its relationship with others in the district has been essential to the success of INDICOM.

Waterford Schools Special Programs

The Data Processing Center and Learning Improvement Center have supported INDICOM by providing technical (computer systems) and content (reading) assistance.

Oakland Schools

There has been a continuing dialogue with the Intermediate School District whose services have been solicited and willingly given. Specific assistance in evaluation and test design can be cited.

The Oakland Schools staff attended half-day orientation sessions for the purpose of (1) providing them with an understanding of INDICOM; (2) establishing a working relationship with the Oakland staff.

Other Educational Units

There has been contact with many other educational units such as many nearby public school systems (Bloomfield Hills, Macomb Intermediate Schools, Detroit, etc.), parochial school systems, foundations (Mott, Kettering, Ford, etc.) and curriculum committees (Michigan Council of Social Studies, MASCD, the Michigan and National Council of Teachers of Mathematics, American Librarian Association, Joint Council of Economics, and Distributive Education Committee).

Universities

The University of Michigan, Michigan State University, Wayne State University, Oakland University and representatives of Stanford University have in various ways contributed to the INDICOM Project. Consultants from the universities helped in initial planning and assisted in hardware selection. A class taught by Dr. Norman Bell was provided for INDICOM staff members through Michigan State University early in the project. Other classes provided by WSU and OU followed.

Other CAI Projects

These are the Philadelphia Public Schools' Project GROW, Pittsburgh's Individualized Instruction Program and the Brentwood School District's Computer Project. INDICOM has had contact and meaningful conversations with representatives of each of these projects. Because of the growing common interest in CAI and the need to exchange information, the National Association of Users of Computer Applications to Learning (NAUCAL) was established in 1969. It has 43 members and INDICOM Director Ron Arnold is a member of the Board of Directors.

Visitations and Presentations

During the third year of INDICOM, approximately 2,100 persons visited the project. The visitors came from 28 different states and from five foreign countries. Most of the visitation activity was inspired by published reports of the INDICOM Project. The highlight of the third year visitation program was the July, 1970 National Conference in Computer Applications to Learning sponsored by INDICOM and the

Michigan Department of Education. Along with the on-going visitation program, the INDICOM staff has always made itself available for outside project presentations. Many of these took place at major national assemblies of educators.

SIGNIFICANT PROJECT DATES

August 28, 1967	First Staff Meeting
Sept. 6, 1967	Dr John Pagen Assumes Directorship
Sept. 11-13, 1967	First Staff Workshop (John Childs, Consultant)
Sept. 26-Oct. 5, 1967	Design Team Recruitment
Nov. 9-11, 1967	First Design Team Workshop
Dec. 16, 1967	Workshop (Florence Striph)
Dec. 21, 1967	Selection of RCA
Feb. 28, 1968	RCA Contract Submitted to U.S.O.E. for Approval
Mar. 10-17, 1968	Palo Alto Staff Workshop - RCA
May 7, 1968	Installation of First 2 Terminals at Riverside
Sept. 23, 1968	Additional 21 Terminals Installed and Operative at Riverside
Oct. 27, 1968	Remaining 9 Terminals Installed
April 25, 1969	Start Series of Meetings with Mott Staff on Their Involvement
Sept. 26, 1969	Use of Terminals at Mott
Dec. 4, 1969	Installation of Computer System at Mott
Jan. 19, 1970	Ron Arnold Assumes Directorship
Mar. 4, 1970	News Conference
July 8-10, 1970	National Conference "Computer Applications to Learning"
Nov. 30, 1970	Termination of Title III Support

The chart on the next page outlines the type of CAI programs completed as of August 31, 1970. Following this is a summary of the objectives and accomplishments of each of the design teams.

BUSINESS

TOPIC SELECTION

Computer Managed Office Education

OBJECTIVES

The ultimate objective of the program is to equip students with the necessary skills, knowledges and attitudes to get and keep entry level office jobs that are compatible with their interests, abilities and occupational and educational aspirations.

UNIT DEVELOPMENT

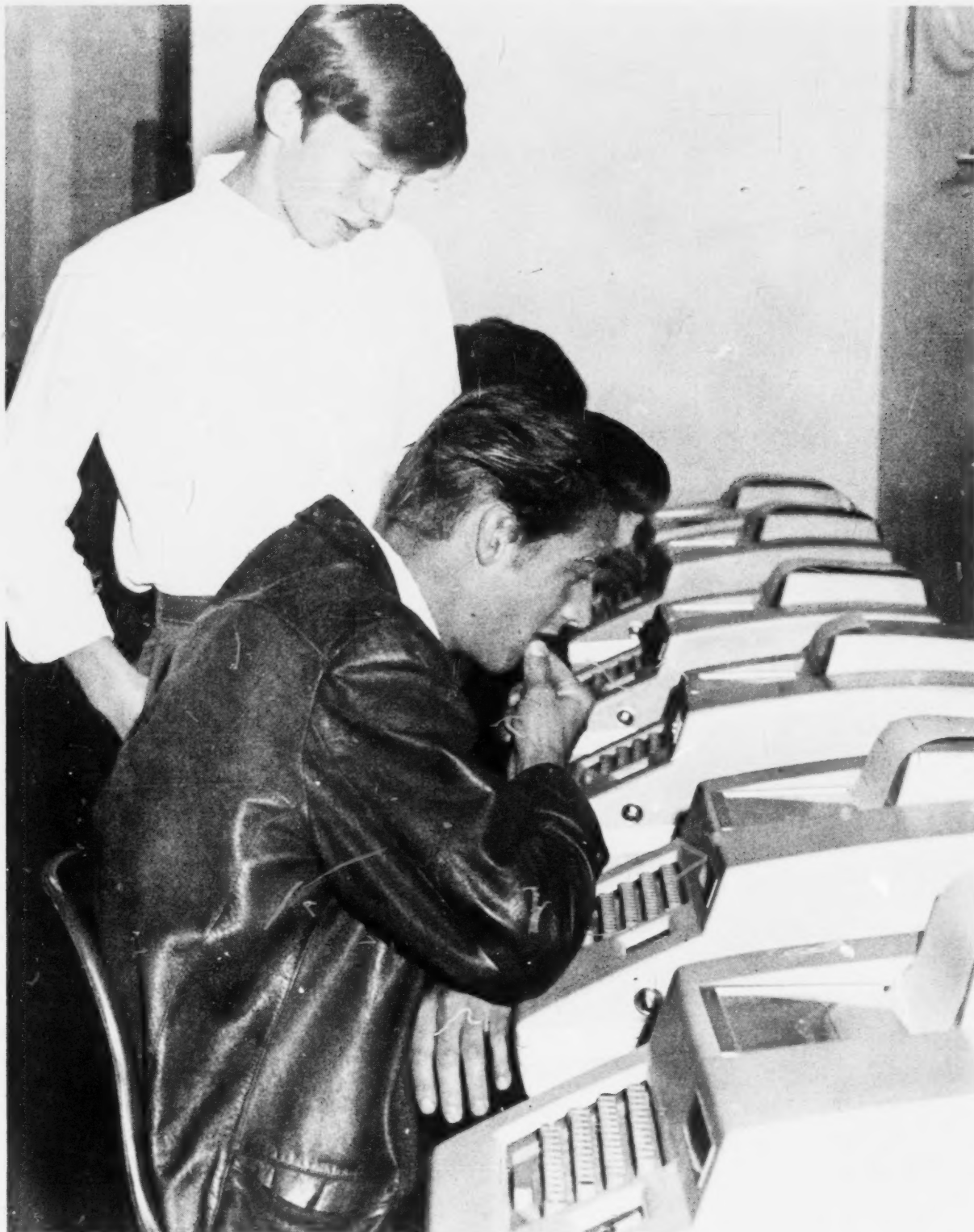
A design for the management of systematic, individualized instruction in office education has been developed by the business team. The system permits students, with the help of teachers and counselors, to choose an occupational goal compatible with their interests and abilities and to work through an individualized sequence of instruction leading to that goal.

The program differs from traditional business education in many aspects:

1. Rather than requiring a series of autonomous classes more or less related, the student's program is prescribed specifically for him as a cumulative learning experience with specific, measurable performance objectives that he can meet by proceeding through an orderly sequence of new learnings based on previous learnings and prerequisite skills the student has demonstrated.
2. Instead of requiring most students in a given curriculum sequence to take the same class, each student's program is individually planned, based on his requirements to meet a specified objective rather than on the content of textbooks, or the lesson plans of the teacher.



CAI has been applied successfully to business education in grades 10 through 12. Reviewing a lesson just completed by a Mott student are (from left) Jan Bachelor, John Shupe and Joan Boose. All three are Mott teachers and INDICOM design team members. Strategies for a Computer Managed Instruction (CMI) model have been developed by this team.



Preliminary analysis of covariance indicates statistically significant gains for high school students in mathematics areas treated by CAI, including attitudes toward mathematics (See description of the William Cole dissertation - Page 26). The secondary students pictured here are working on a mathematics lesson at the Mott Lab.

3. Rather than assuming the existence of prerequisite skills in basic language arts and mathematics, student proficiency is assessed and deficiencies treated.
4. The program assures that the student receives instruction and counseling in self-assessment, realistic career planning and the techniques of job getting.
5. Rather than setting the same goals or no goals for students in office education, the program assures that each student may achieve a first level of competency by dealing with selected concepts at the beginning of student enrollment and by individually prescribing instructional units.
6. The student is not restricted to learning only through classroom instruction, but has the opportunity to learn at his own rate in a variety of instructional settings.

Five occupational choices are the basis for the initial program design: Clerical-clerk, Clerk-typist, Clerk-stenographer, Receptionist, and Secretary-filing. For each of these occupational goals there is a prescribed sequence of instructional units.

Performance objectives, which served as the framework for planning the instruction, were developed for each of the units together with appropriate pre and posttests. A student may test out of any unit in which he can demonstrate the required level of proficiency. The units are not limited to any single method of media. Some involve a minimum of independent work combined with group instruction, while others may require only independent study through CAI or other programmed materials.

Before entry into the specific instructional sequence, every student is required to take instruction in basic vocational and clerical concepts and to demonstrate the requisite level of proficiency in basic language and computational mathematics skills (Remediation is provided for those who need it).

Cooperative work experience is recommended for all students and final instruction in post secondary planning is required to complete the program.

CLASSROOM MANAGEMENT

TOPIC SELECTION

The team members are a school district social worker and a district psychologist. Noting that much of their time is spent helping teachers cope with problems related to classroom management and disruptive student behavior, the team concluded that there is a definite need to develop instruction that would give teachers a working knowledge of a variety of behavior modification techniques. Such a program would make the teachers' job easier and free counselors and school social workers to spend more time counseling individual students.

OBJECTIVES

The goal of the Classroom Management Team is to provide teachers with techniques and procedures which can be employed to promote more appropriate social functioning in the school setting. The terminal behavioral objective is:

The teacher will be able to analyze given classroom situations, identify specific target behavioral and write or identify a behavioral prescription (using behavioral learning theory and psychological concepts) for the specific classroom situation.

AUDIENCE

Beginning teachers, student teachers, experienced teachers in in-service training.

UNIT DEVELOPMENT

The team has collected reference materials and has corresponded with other researchers doing related work. It has consulted with specialists at Michigan State University and The University of Michigan as well.

The team has developed introductory units on defining effective rules and on positive reinforcement. It also has developed a collection of

problems which may be used by the teacher (who is in this case the student) to develop solutions to similar problems in his own classroom.

DEVELOPMENTAL TESTING

Pretests and posttests have been developed for both of the introductory lessons.

LANGUAGE ARTS

TOPIC

The Language Arts Team began its work by developing performance objectives in writing, listening and reading for kindergarten through grade twelve. Beginning with the recognition of upper and lower case letters, the team defined a cognitive structure for the writing skills which included 32 stages or steps leading to the final objective of writing coherent and well developed paragraphs.

Originally, the team planned to use this framework as a guide for developing curriculum for all grade levels, but it soon became apparent that such an ambitious task could not be completed within the time limits of the project. Analyzing the resources of the team, the nature of computer assisted instruction, and needs of Waterford students, the team concluded that its efforts could be most profitably directed toward designing developmental and remedial instruction in the basic language arts skills for under and low-achieving secondary students.

UNIT DEVELOPMENT

The team has completed a semester program designed to provide instruction, drill and review in the basic skills of grammar and sentence structure requisite to the development of proficiency in written language.

The CAI program is divided into 21 units. Each unit contains a leveling pretest and one to five days' lessons. Each day's lesson is written on three levels of difficulty to allow for individual differences in learning rate and achievement. Each lesson at each level contains a tutorial file and an application file. The tutorial file is designed to teach a given concept and the application file provides drill and practice in the concept.

The entire program is prefaced by a general diagnostic test to determine which of the units the student needs. On the basis of this test, the student's instructor prescribes and sequences the required instructional units. Student entry into each instructional unit is accomplished through a leveling pretest which determines the level of difficulty of the first day's lesson. The level of the second and subsequent lessons within a unit is determined by the student's performance on the application file of the preceding day.

ILLUSTRATION OF LEVELING

The program also includes five review units which may be scheduled at the instructor's discretion.

The language arts program has been loaded on the I-71 system and is now being used in the pilot Communications and Mathematics Skills Program (CMSP) at Mott High School. The language arts lessons are also used in the Adult Basic Education program and in the business team's Computer-Managed-Instruction program.

DEVELOPMENTAL TESTING

Many of the units were tested in a paper and pencil format and revised. Several were tested "on-line" and revised. These were used as guides for the development of other lessons.

Following the pilot on-line run of the entire program, a final revision and lesson evaluation will be made.

MATHEMATICS

TOPICS

- A. Estimation, approximation, fractions, decimals and percents - 150 lessons each on 3 levels of difficulty.
- B. Time Telling - 20 lessons incorporating visual displays and audio instruction.
- C. Measurement - 15 lessons incorporating visual displays.
- D. Matrices - 9 lessons incorporating visual displays.

OBJECTIVES

Definite terminal and intermediate objectives have been developed for each unit.

AUDIENCE

The units on estimation and approximation, measurement, fractions, decimals and percents have been incorporated into the Communication and Mathematics Skills Program (CMSP). The units on estimation and approximation are also being used for later elementary students (grades 4,5, and 6) and the units on fractions, decimals, percents and measurement are being used for junior high students and Adult Basic Education. The time telling units are designed for early elementary students (grades 1, 2, and 3). The matrices lessons are written for advanced algebra students in grades 11 and 12.

UNIT DEVELOPMENT

Flow charts were developed for each instructional sequence. Terminal and intermediate objectives were stated in behavioral terms and appropriate prerequisite and criterion tests were developed with the lessons. All lessons were first written in a format that could be tested and revised before the final computer encoding. All lessons have been revised at least one time. Many have been revised several times. Thirty estimation and approximation lessons have been tested "on-line" and revised.

In addition to the CAI programs, the team has also developed several single concept instructional management booklets. The booklets are designed to help students learn a given concept by working through a series of auto-instructional lessons. Working independently, the student tests himself after each learning activity and proceeds to the next activity on the basis of his test score. The materials used in these programs include non-CAI lessons as well as portions of the L. W. Singer mathematics program.

DEVELOPMENTAL TESTING

A general objectives test for estimation and approximation was designed and administered to 4th, 5th, 6th, 9th, 10th and 12th graders. It was item analyzed and furnished additional directions for unit development. Unit pre and posttests and diagnostic tests have been devised for all sequences.

All lessons have been tested in a paper and pencil format at least once and revised. Many of the units have also been tested on-line and revised. The Stanford Achievement Tests are being used to test overall achievement on the programs.

MUSIC

TOPIC

The Vocabulary of Music

OBJECTIVE

The primary objective of the music program is to provide students with a working vocabulary of musical terms.

UNIT DEVELOPMENT

Originally the music team hoped to use the I/71 audio system to teach rhythm and music notation. However, the delays in the development of the audio system caused the postponement of this curriculum development.

Therefore, the team chose to write an introductory program for either a musical literature class or a performance class. Basically the program is designed to insure that students acquire the necessary vocabulary to understand the classroom music instruction. The program not only provides an efficient means of teaching this vocabulary, but through teacher reports, should serve as a guide to indicate to the instructor concepts in which additional instruction in the classroom may be needed.

Eight units have been written:

1. Basic Rhythms.
2. Melody in Bass and Treble Clef.
3. Voice Classification.
4. Classical and Popular Vocal Style.
5. The Musical Show.
6. Tempo.

7. Form in Music

8. Musical Instruments

Several of these units are augmented by the I-70 Visual Display Unit. A teachers' manual has also been developed.

EVALUATION

These have all been used in paper and pencil format. Further evaluation will take place following an on-line run.

READING

TOPIC SELECTION

Supplemental Reading Instruction in Word Attack Skills

Phonic Analysis

Structural Analysis

OBJECTIVES

Students will master the phonetic skill necessary to attack words independently and have sufficient adeptness in structural analysis to read with ease and comprehension.

AUDIENCE

Students reading at a typical third grade level, both children and adults.

UNIT DEVELOPMENT

Scope and sequence charts from approximately twenty-five basal readers, phonic and spelling workbooks were examined. From these was derived a list of skills that are taught at third and fourth grade levels. These were then divided into phonic analysis and structural analysis. The skills were further divided into units which vary in size from four to ten lessons.

The program is designed to be used wholly or in part at the discretion of the teacher.

DEVELOPMENTAL TESTING

Pre and posttests are written for each unit. Selected units were tested on the teletype.

OTHER

The team originally focused on a developmental reading program but decided to delay such an approach until computerized audio was available.

BASIC READING SKILLS--SCOPE AND SEQUENCE

Structural

irregular plurals such as "children"

finding root words

"es" forms of nouns and verbs

"er" and "est" forms

changing "y" to "i" in verbs

structural endings of "en", "s", "ed" and "ing"

plurals with "s", "es" and "y" words

doubling final consonants

"ed" and "ing" endings on root words

methods of dividing words into syllables

prefixes--"a", "be", "un", "re", "dis", "in", "im", "ex",

"pre", "pro" and "de"

suffixes--"ful", "less", "y", "ly", "er", "or", "ish",

"ment", "able", "ous", "er" and "est"

recognizing syllables

affixes

compound words

synonyms

antonyms

homonyms

contractions

possessives

abbreviations

accents

Phonetic

initial, medial and final consonants

initial, medial and final consonant blends

initial, medial and final consonant digraphs

variable sounds of consonants such as "c" and "g"

make use of consonant substitution to form new words

silent consonants in words

long and short vowel sounds

vowel digraphs

vowel diphthongs

"r" influenced vowels

schioa sound of vowels in unaccented syllables

determining vowel sounds by position

variant spellings of vowel sounds

silent "e" rule

sound of "a" when followed by "l" and "w"

special sounds of "ci", "si" and "ti"

words ending in "le"

rhyming elements

irregular vowel sounds

three sounds of "ed" ending

diacritical markings

four sounds of "s"

"dge" ending

Comprehension

apply new ideas

follow sequence of events or ideas

draw conclusions

see relationships

predict outcomes

follow directions

read for definite purpose

find proof

SCIENCE

TOPICS

Mineral Identification

Igneous Rocks

Sedimentary Rocks

Metamorphic Rocks

Genesis of the Earth

Ecology

Producers and Consumers

Plant and Animal Adaptations

Population Dynamics

OBJECTIVES

The scientific process of observation, hypothesizing, theorizing and categorizing are emphasized. Behavioral objectives have been written for each lesson.

AUDIENCE

The program is specifically designed for 6th grade but may be used by any group which has attained a 4.5 grade reading level.

UNIT DEVELOPMENT

Actual mineral sample kits are a unique feature of the science program. The student works through mineral identification problems according to directions given in the teletype-presented instruction using the samples of minerals and chemicals provided in the kits. Other instructional aids utilized in the programs are slides projected by the I-71 Visual Display Unit and manual flip charts. A detailed teachers' manual developed by the team suggests additional classroom activities and experiments to supplement the CAI instruction.

The two programs, Ecology and Mineral Identification, are independent of one another. The first units of the Mineral Identification program also may be used independently, though the fourth unit requires the successful completion of the first three. The first two units of the Ecology program are independent, but are prerequisites to the third unit. There are a total of fifty-six lessons in the two programs plus pre and posttests for each of the seven units.

DEVELOPMENTAL TESTING AND EVALUATION

The Mineral Identification program was entered on the I/70 system, tested and revised. Both programs will be tested, revised and evaluated on the I/71 system.

SOCIAL STUDIES

TOPIC

The team agrees with current thinking in education which redefines the goals of social science instruction. A collection of facts about today and yesterday is no longer an acceptable objective. Students must be given the tools which will enable them to understand and function effectively in the rapidly changing social milieu. This approach to social science teaching may be called problem-solving, the process approach.

Specific objectives for each of the thirty-five lessons have been written.

UNIT DEVELOPMENT

The team has developed an extensive program of thirty-five lessons divided into six units in the categories of Defining the Problem, Information, Developing Hypotheses and Testing Hypotheses. These are followed by five gaming problems in which the student is required to solve the given problem using the techniques he has learned.

Designed for a 9th grade audience, the program could be used independently, but the authors feel that it would be more effectively used in conjunction with other classroom activities. A complete teachers' manual suggesting supplementary classroom work has been written by the team.

EVALUATION

The units have been used in a paper and pencil format. Lesson revision and some unit reorganization has been done as a result of classroom trials of printed lessons. Further evaluation and revision will occur following the pilot I-71 on-line run.

SPELLING

TOPIC

Spelling Rules

UNIT DEVELOPMENT

The INDICOM Spelling program was the first to make extensive use of the I/71 audio system. Designed for an audience which has attained a third grade reading level, the program is constructed as a modified strands approach to teaching spelling rules and generalizations. A diagnostic pretest identifies those generalizations in which the student requires instruction and drill.

Five hundred words are recorded on the audio disk of the INDICOM Project's RCA I/71 Computer System. Each of these words is keyed to the applicable spelling generalizations stored in the computer memory bank. The computer is programed to scan the audio vocabulary and terminal word list to generate random lists of appropriate words for the spelling drills at the end of each lesson. The drills are programed to provide massed and distributive practice as the student progresses through a unit.

The instruction (as opposed to the drills) is presented via teletype student terminals. Each unit is designed as self-contained, tutorial instruction. The spelling rules are explained and the student is asked to apply the rules to a number of examples. He may also be required to apply the rules to nonsense words and to discriminate correct from incorrect spelling. Each unit contains two to four lessons plus reviews and spelling games.

The program is presently a prototype which will be expanded. The first units teach those generalizations which research indicates cause the greatest number of spelling errors. The eight completed units deal with the following:

1. Syllables
2. "ing" endings
3. Plurals
4. Possessives

5. Hyphenated words
6. Abbreviations
7. Contractions
8. Compound words

EVALUATION

Evaluation will occur during 1971.

SUMMARY OF THE ACTIVITIES AND FINDINGS OF THE INDICOM PROJECT

1967-1970

Prepared By:

Dr. John Pagen
Superintendent, Waterford Schools
(Director, INDICOM Project, 1967-1969)

Mr. Ron Arnold
Director, INDICOM Project

In 1967, Superintendent of Waterford Schools, the late Dr. Don O. Tatroe, and the Secondary Coordinator, Mr. Roy Alexander, conceived a plan to use computer technology to improve the instructional offerings to students in the district. Waterford at that time had had several years experience with the district Data Processing Center that was used during school hours for instruction in the computer sciences and problem solving applications and in the evenings for administrative applications. The question posed was, "Could the computer be used to directly assist in the instructional process?" Some three years later and after thorough analysis of evaluation data, we can state with confidence that the computer is a viable medium for the instruction of youngsters, particularly in the basic skills area.

In CAI the computer is employed primarily to develop imaginative and innovative methods of teaching students. The speed and storage capability of the computer make it ideal for individualized instruction. There is immediate attention to the response of the students. The student is placed at the level of difficulty sufficient to challenge him, but not so difficult that it frustrates him. The program is designed so that the youngster finds success (a rule of thumb is that 90% of the students should succeed on 90% of the items). The computer responds patiently to the input of the student and is not concerned with family background, color, physical appearance nor his disposition to school - but rather to the response he makes to the educational problem. The interaction between student and machine is a very

personal relationship. (It is interesting to note that we've not had a single case of student vandalism on any of the 32 terminals in over two years of operation and over 300,000 student contacts.) There is little doubt that carefully designed CAI improves student performance and attitude toward school, subject matter and achievement.

INDICOM AND ACCOUNTABILITY

The acronym INDICOM equates to individualized communication. This is the essence of the teaching-learning dilemma. How can we communicate with the individual youngster? Accountability for individual student progress is the essence of the evaluation of the project. We define accountability as including these elements:

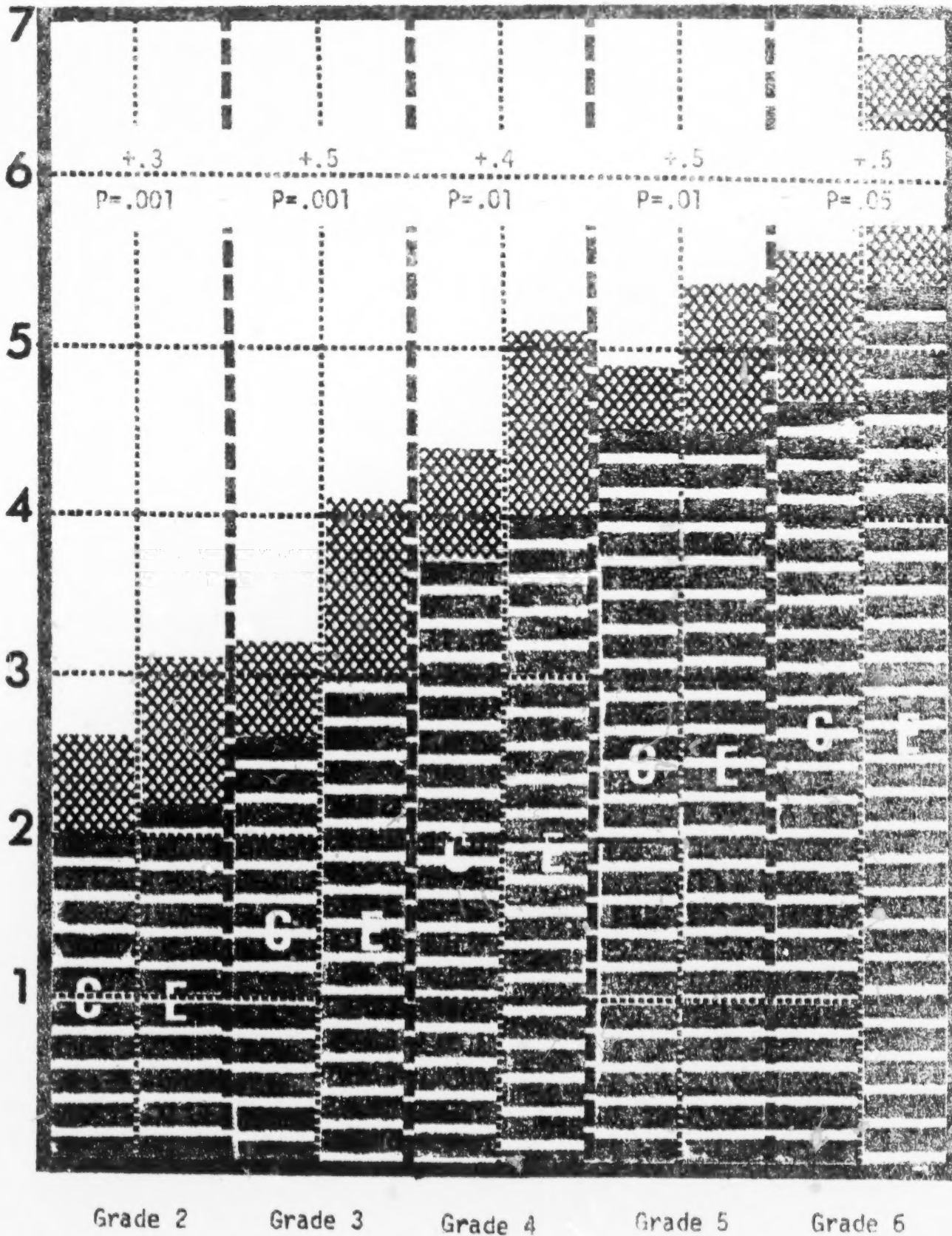
- the ability to diagnose youngsters' readiness for a given learning activity and to determine if the student really needs the instruction;
- the ability to prescribe instruction to meet the needs reflected in the diagnostic instruments;
- and a continuous process of evaluation to determine subsequent needs and the effect of the instruction. The computer is uniquely equipped to store large amounts of data on students, curriculum, and evaluation, and to make decisions on this data based upon pre-designed programs.

We believe an accountability audit is mandatory for a project of this size and we commend your interest in our accomplishments.

A Review of Objectives, Accomplishments, Problems, Funding, et al ---

The following pages are devoted to reviewing the objectives and accomplishments of the INDICOM Project as well as noting the problems that have been encountered in this major project relating both to instruction and to inadequacies in federal funding.

SAT MATHEMATICS TEST RESULTS GRADES 2-6 1969-1970



OBJECTIVES AND ACCOMPLISHMENTS

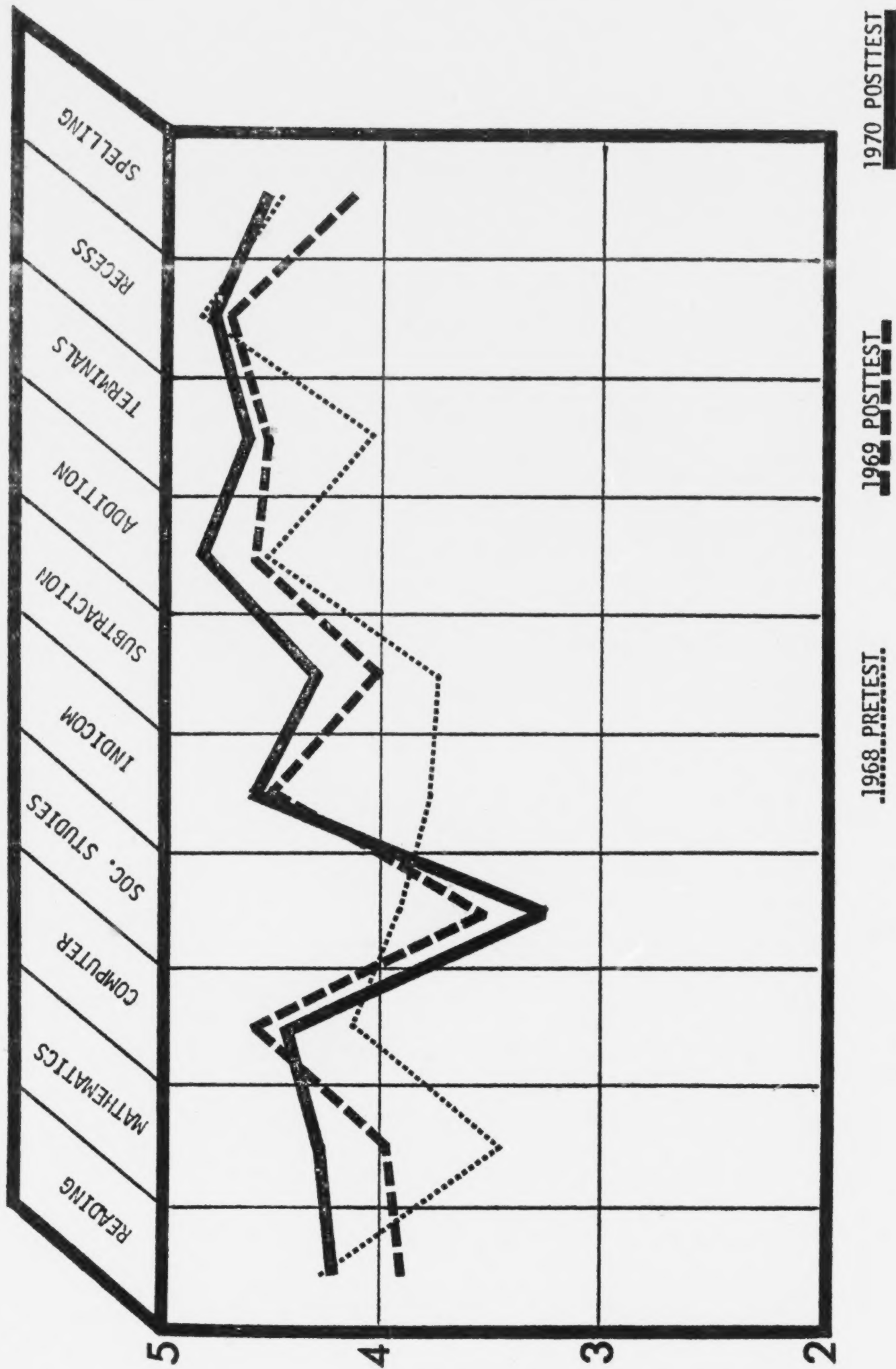
The general objective of the INDICOM Project was to improve instructional offerings for youngsters by employing computer technology. Specific objectives include the definition of curriculum goals in specific behavioral terms; the establishment of efficient and effective training programs for district personnel; the investigation of the growth made by participating students; the investigation of whether or not computers do, in fact, assist the teachers and relieve them of routine tasks to conduct more creative activities; to point the direction towards defining the role of students and teachers in a program of computer assisted instruction; and to develop an effective dissemination program for the INDICOM Project. External and internal evaluations would indicate that the project has been an overwhelming success in meeting these objectives.

There are numerous reference documents available that detail the statistical analysis of the measures of achievement in the project.

In summary, INDICOM, over the last two years, has demonstrated the following:

- the ability to manage a major innovative project through conception to implementation - reporting evaluation data fairly and accurately;
- achievement in mathematics and language arts can be extended and accelerated by CAI. This fact has been documented by testing in the elementary and high school levels. The summary of the math evaluation data clearly shows significant gains at all levels. (Incidentally, the recent State Assessment data corroborates the findings of the elementary program). You will note in the SAT Mathematics Chart that each grade level had significant differences in favor of the CAI (experimental) group beyond $P = .05$. It should be noted that all Waterford elementary youngsters were on reduced schedules during 1969-1970.
- student attitudes towards mathematics and language arts improves when CAI is utilized (State Assessment data supports this finding, also). See Attitude Survey Chart.

ATTITUDE SURVEY FOURTH GRADE



- preliminary analysis of data indicates statistically significant gains in all mathematics areas treated by CAI for Senior High School underachievers and low achievers.
- a small pilot study with eight adult basic education students showed a gain in mathematics achievement of three years (average) in ten 1 1/2 hour sessions.
- students continuing interest in CAI indicates that the improved performance is due primarily to the personalization of instruction, that is afforded through CAI rather than the initial impetus provided by the hardware. While it is still too early to completely write off the possibilities of the Hawthorne effect, we find no indication of waning interest on the part of students.
- teachers who apply the logic of the systems approach to CAI design appear to exhibit a more positive attitude toward teaching and learning in general; that is teachers are more inclined to view teaching and learning in a cause and effect relationship which, again, is the essence of accountability;
- the development of CAI at this point in time is a demanding and costly process that requires funding beyond the normal budget of any school district;
- there is sufficient subjective data to indicate that CAI is particularly appropriate for youngsters classified as handicapped learners, specifically the deaf and mentally retarded. We have a major proposal submitted to the U. S. Office of Education (and reviewed by State Department officials dedicated to formal work with this audience).
- the curriculum design work in the project has had significant impact upon the school district as a whole. The employment of the systems approach to curriculum development and the use of sophisticated management techniques such as PERT have been widely disseminated in the district to the ultimate benefit of all students in the school system.

In summary, there is little doubt that the significant gain data in the experimental groups can be attributed to the uniqueness of the approach afforded through computer assisted instruction.



There is sufficient subjective data to indicate that CAI is particularly appropriate for youngsters classified as handicapped. Robert Hardenburgh (pictured above) is a student in the special program for hearing impaired youngsters.



Dr. John Pagen
Superintendent Waterford School District
(INDICOM Project Director 1967-1969)

"As a concluding observation I would emphasize that the most critical consideration is this: True individualization of instruction is not going to occur unless we utilize technology. Only the computer is capable of bringing to bear, at the decision-making point, the kind of information required to properly prescribe instruction on the basis of valid diagnosis. It seems to me that the computer route is the way we must go eventually. I'm convinced that all our problems relating to hardware, and I mean the problems of memory, initial cost, maintenance and telecommunications, will eventually be overcome. . . . It is obvious that, for a time, we must not become hardware-fixated but rather focus on the educational decisions that need to be made in order to make broadly based computer assisted instruction a reality."

A project of this magnitude and this importance presents a major challenge to a district of this size. Very few of us in our lifetime really have an opportunity to work with a program that we believe will really change the destiny and the structure of American education. We have welcomed and have urged external evaluation of the effectiveness of this staff in accomplishing our charge. Don Goodson, Coordinator of ESEA Title III, his staff, and appointed evaluators have been primarily charged with this responsibility. From all feedback that we have received, both formally and informally, I believe we can state with confidence that they consider the project operation to be extraordinarily sound.

This unique and highly sophisticated computer assisted instruction project is aimed at individualizing the instruction of elementary and secondary school youngsters through pioneering in sometimes unknown areas of computer technology. Local teachers write computer programs in the areas of math, science, business, humanities, industrial arts, language arts and reading, social studies, guidance, and classroom management. The implications of INDICOM are great for future education in Michigan and the nation. Disregarding the CAI aspect of this program, the project could still serve as a model for other school districts of thorough and sound curriculum development with widespread teacher involvement and well planned evaluation techniques. *

Project operations for the past three years can be summarized as follows:

Year 1 was primarily committed to the planning of project activities, recruitment and selection of staff, training of personnel, negotiations with and selection of the vendor and development of evaluation documents.

Year 2 we moved to an operational stage on RCA's computer system in Palo Alto, California; we continued curriculum preparation; a massive dissemination program was begun; we continued our training efforts and further developed our evaluation activities.

- * Miller, Peggy, "Waterford Public Schools - INDICOM (Individual) Communications System" MASB Journal - December, 1969.

Year 3 has been characterized by the transition to the on-site computer system (RCA 1/71) with all the normal installation problems and the field-testing and revision of curriculum; major evaluation activities have been completed; dissemination efforts have been highlighted by on-site visitations, a National Conference co-hosted with the State Department of Education and numerous other techniques such as periodic newsletters, slide tape presentations and the like.

Based upon the soundness of the evaluation data, project continuation is our primary focus at this time.

In this section on Objectives and Accomplishments we have summarized the data from the INDICOM Project. A question could be raised as to whether CAI would be as appropriate for a student population that was quite different from that in Waterford, specifically, the inner-city black, Spanish American, and rural student. The New York City CAI Project worked primarily with inner-city black and Puerto Rican students. The McComb, Mississippi CAI student population was primarily rural black and white students. Both of these projects reported dramatic gains in achievement by the CAI groups in 1968-69 when compared to non-CAI instructional groups. These two projects used the same mathematics curriculum as INDICOM during the 1968-69 school year and their findings would support our conclusion that computer assisted instruction in mathematics does significantly improve youngsters' performance.

PROBLEMS AND SERENDIPITY

In a major innovative project it is just as important to report the problems as the promise. All too often people forget that negative findings, honestly reported, are as important as positive findings. The most significant problem was our inability to accurately assess the magnitude of the task that we had undertaken. This was true also of the hardware supplier, RCA. Although the 1/71 system is completely installed, the system is not performing to expectations, particularly the audio and graphic enhancements. Some difficulty must be expected as these two enhancements are right on the cutting edge of instructional technology. There are few references for comparison, so problems must be expected. However, some of the problems we're now having are beyond the range of normal expectancy and we intend to hold RCA to the contractual commitments.

We have every reason to believe that RCA will maintain its commitment until the 1/71 System is a viable system.

Severe problems have resulted from spiraling costs and inadequacies in federal funding. Appropriations have never equalled the funding

and we were asked to make reductions in programs at the least opportune time. For instance, in the third year of the project, our full-time staff was reduced by 30%, design team activities reduced by 75% and in-service training of our other staff almost totally eliminated.

The development of computer assisted instruction seems to crystalize all that we don't know about teaching and learning! Several programs that were developed simply did not work. In science, for instance, we developed elaborate branching techniques that confused rather than directed students. We've been guilty of underestimating the student consistently in terms of what he is able to do when presented materials at the appropriate level with a high probability of success. We have discovered whole new problems in terms of copyright and costing of instructional materials. (How does a publisher price CAI materials? On one disc an entire curriculum could be stored for use by any school district anywhere in the country provided it had access to the I/71 System.) How do we protect the confidentiality of student performance and historical data and still provide it in a meaningful format to classroom teachers? We discovered that providing the teacher too much data may be a problem; reports with too much detail on student progress tend to be confusing rather than enlightening to the teacher.

There are a host of unresolved problems in the use of computer technology in instruction. But problems always accompany significant change. We need to know more about how students learn, how most efficiently to use teacher time and how to program effectively for true individualization of instruction. Research at Florida State University indicates that individualized instruction itself is more appropriate to the youngster with certain personality characteristics. These problems need further research.

- Students (especially the handicapped) typically performed at a higher level than was expected and exhibited few problems with the operation of the terminals;
- the student proctors provided invaluable aid in the preparation and loading of CAI, the monitoring of students, and the handling of visitors - while at the same time developing sophisticated skills in the computer science;
- eleven year old students have written, coded and loaded their own spelling curricula using the SIMPLE Language;
- the project served as a catalyst for advanced studies. Over 1/2 of the full time staff and many of the design team staff received advanced degrees over the last three years. Several doctoral dissertations have been written or are in the process of being completed around project data.

- elementary students can actually enjoy academic summer schools (in addition to showing achievement gain.)
- not the least of the benefits for Waterford and the State of Michigan has been the visibility provided the district and the state. Several thousand visitors have examined the INDICOM facilities from most of the fifty states, Canada, and many foreign countries.

DISSEMINATION

Dissemination is a very necessary and a very costly function of a project of this nature. We've had over 2,000 visitors to the Mott CAI Lab alone since February 1, 1970. We have been committed from the beginning that our public relations would not exceed our progress. We found this to be the case in many visitations we made early in the project. However, in terms of "grantsmanship," honesty is sometimes a handicap. The July, 1970 National Conference in Computer Applications to Learning sponsored by INDICOM and the State Department of Education was designed to be the culminating dissemination activity of the three year project.

The evaluation of the conference indicated it was a tremendous success. INDICOM'S prominence in National conventions and even in International meetings indicates the regard the educational and computer community holds for the worth of project activities.

FUNDING OF PROJECT ACTIVITIES

The 1960's have been characterized by the application of computer technology to effect better accounting practices in education, to train youngsters in the computer sciences, and to instruct youngsters in the use of a problem-solving tool. The 70's, from all evidence, will be characterized by the use of the computers to directly assist us in the instructional process.

If we really believe that we must find ways to educate all youngsters, then we must recognize the tremendous problems concomitant with that goal. Instruction becomes increasingly complex as more youngsters stay in school for longer periods of time. It is estimated, now, that the amount of knowledge available in this society doubles every ten years. The cost question may ultimately be, "Can we afford to do any less than provide the personalized instruction that is available through the use of the computer in instruction?"

The immediate financial operation problem facing INDICOM is securing adequate funding for continued research and development activities. We have proposed that the State Department of Education and State Board of Education support project activities by:

- (1) meeting the financial obligation to RCA, contingent upon satisfactory performance of the system, of \$153,650.00 out of ESEA Title III funds. (The Michigan Board of Education and Department of Education have provided these funds through a supplementary ESEA III grant);
- (2) supporting continuing operations in the district through either direct allocation or through consideration under categorical funding. The continuing costs for the project range from a minimum of \$70,000 for operation per year to a maximum \$400,000 a year for regional center;
- (3) continuing to support the school district in the solicitation of funds from Federal and private sources for research and development in instruction. The project has demonstrated the benefit of CAI to youngsters and current projections indicate that hardware costs will greatly diminish in the next decade.

Michigan is in a position to maintain its leadership role in this area by careful planning and investing at this time.

The curricula and software developed in Waterford should be of great interest to other school districts as they move toward CAI. Many school districts have inquired as to the availability of INDICOM lessons for their use. As the material was produced in the public domain, it would be available to other users. On-site computer systems are becoming more common. As this trend continues and accelerates, more and more school districts will begin to look at computer technology for direct assistance in the instructional process. It is critical to the taxpayers that the future CAI developments in this State use the accomplishments and failures of the INDICOM Project as a point of departure. Costly duplication of effort cannot be tolerated in the development of computer based instructional systems as the initial costs will be very substantial.

The Waterford School District Board of Education stands ready to support the project within the limited resources of the school district. Waterford has one of the highest operating levies (30.63) in the State. Even with this substantial effort it will be difficult to restore youngsters to full programs. Three years ago it would have been very difficult to predict the soaring salary schedules and the emergence of powerful employee bargaining units. The full support for the INDICOM Project would be simply beyond the ability of the district. Continuing discussions are taking place with RCA concerning their corporate commitment to CAI and to Waterford in particular. RCA has invested millions of dollars in CAI development and can't be expected to assume 90% of maintenance costs

indefinitely. We propose that the full value can be extracted from the project through a cooperative tripartite funding arrangement of Waterford, public funding sources, and RCA. The ultimate objective would be to have the I/71 System an affordable instructional medium for this school district and others.

The hard data available from the project, external evaluators and State Assessment demonstrates that CAI can improve youngsters' achievement in the basic skills areas; in addition, the CAI student manifests a more positive attitude toward school.

Indications are that hardware costs will go down in the seventies and that widespread application of CAI will be a reality.

Dr. Patrick Suppes of Stanford University observed that " . . . it is of the greatest importance to emphasize that the existence of the technology and the recognition of its possibilities are not in themselves sufficient to guarantee that it will be used wisely or that it will be used with anything like maximum efficiency. From the standpoint of educational theory and practice, the deep and complicated problems begin only when it is recognized that the technology is ready for application and that we need to understand how it should be used." * The State has much to gain by insuring the perpetuation of instructional related computer activities in Waterford until full value has been extracted.

In conclusion, we respectfully acknowledge the cooperation and encouragement we have received from the State Department of Education - particularly the ESEA Title III offices under the direction of the late Don Goodson.

* Suppes, Patrick; Jerman, Max; and Brian, Dow; Computer-Assisted Instruction; Stanford's 1965-66 Arithmetic Program, Academic Press, New York, 1968, p 2.

GLOSSARY

Access Time

The time it takes the computer to locate data in its storage section and transfer it to the arithmetic unit, where the required computations take place; also, the time it takes to transfer information which has been operated on from the arithmetic unit to the location in storage where the information is to be stored.

Author

One who designs and writes a course for computer-based instruction.

Bit

An abbreviation of binary digit; the smallest unit of information in the computer, being dual-state (on or off, one or zero).

Byte

A group of adjacent binary digits usually operated upon as a unit, and shorter than a word. In the Spectra 70/45, a byte contains eight bits.

Cathode Ray Tube

An electronic vacuum tube containing a screen on which information may be stored or displayed.

Central Processing Unit

The portion of the computer containing the arithmetic, control, and main storage units.

Code

A system of symbols for representing data or instructions in a computer.

Command

The portion of an instruction which specifies the operation to be performed.

Computer

A device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes; usually consists of input and output devices, storage, arithmetic, and control units.

Computer-Based Instruction (CBI)

Instructional method using a computer system for presentation of materials, evaluation of response, scoring and grading, and other functions.

Concept Block

A set of data base materials covering a specific concept within a course. In the Mathematic Drill and Practice program published by L. W. Singer, a concept block includes a pretest, posttest, and five days of drill and review.

Configuration

A group of machines which are interconnected and are programed to operate as a system.

Course

A set of instructional materials covering a specific subject (e.g., mathematics, reading).

CRT

(See Cathode Ray Tube)

Curriculum Data Base

Lesson materials stored on magnetic disc and available as needed by the procedure program. Contains questions, answers, tutorial text, control information, and any other data needed during course presentation.

Data

Basic elements of information (facts, numbers, letters, or symbols) which can be processed or produced by a computer.

Data Set

A device used to convert data signals to and from other signals which can be transmitted; used to permit data communication over telephone channels.

Data Translator

A program for translation of specially coded curriculum materials, into a specialized format which can be used by a procedure program.

File

An organized collection of information directed toward some purpose and treated as a unit. In CBI, a curriculum file usually represents all or part of the subject matter information needed for a particular lesson.

File Maintenance

The periodic modification of a file to incorporate changes which occurred during a given period.

Flow Chart

A graphic representation of the major steps in a program or a system of programs. Symbols are used to represent operations, data, flow, and equipment.

Hardware

The physical equipment or devices forming a computer and its peripheral equipment. Contrasted with software.

Input

Information or data transferred from an external storage medium into the internal storage of the computer. Also describes the routines which direct input, or the devices from which such information is available to the computer.

Input Device

The mechanical unit designed to bring data into the computer, e.g., a card reader, tape reader, keyboard.

Language

A system for communicating information between people, or between people and machines. Such a system consists of a carefully defined set of characters, rules for combining them into larger units such as words and expressions, and rules of word arrangement to achieve specific meanings.

Line Concentrator

A small computer used in the CBI system for directing and controlling the flow of information between the control computer and instructional terminals. Also performs other miscellaneous functions, e.g., issuing standard messages to terminals.

Load

To place data into internal storage.

Magnetic Disc

A storage device on which information is recorded on the magnetized surface of a rotating disc. A magnetic disc storage system is an array of such devices, with associated reading and writing heads mounted on movable arms.

Magnetic Tape

A storage device in which data is stored in the form of magnetic spots on coated plastic tape. Binary data are stored as small magnetized spots arranged in column form across the width of the tape; a read-write head is associated with each row of spots.

Main Storage

Usually the fastest storage unit of a computer and the one from which instructions are executed. Contrasted with auxiliary storage (e.g., magnetic disc, magnetic tape).

Mass Storage (on-line)

The storage of a large amount of data which is also readily accessible to the central processing unit of a computer. An example is the mass storage of curriculum on magnetic disc.

Message

A definite sequence of letters, digits, symbols, etc. Especially sequences of characters displayed at the instructional terminal.

Microsecond

One millionth of a second, abbreviated Microsec.

Millisecond

One thousandth of a second, abbreviated Msec. or Ms.

Multiplexing

The interleaved or simultaneous transmission of two or more messages for a single channel; the process of transferring data from several storage devices operating at relatively low transfer rate, in such a manner that the high-speed device is not obligated to wait for the low-speed devices.

Nanosecond

One thousandth of a millionth (i.e., a billionth) of a second.

Off-Line

Pertains to equipment or devices not in direct communication with the central processing unit of the computer; also used in CBI to refer to processing done during non-CBI hours, i.e., when students are not communicating with the system from terminals.

On-Line

Pertains to equipment or devices directly connected to the central processing unit; also used in CBI to refer to CBI hours, when students and teachers can communicate with the system through terminals.

Output

The information transferred from the internal storage of a computer to an external device; used to refer to the routines which direct the output, and the device or set of devices necessary for output.

Parameter

A variable that is given a constant value for a specific purpose or process.

Performance Record

A record on magnetic disc, in the Student History Vector file, containing performance information on a student registered in a CBI course.

Peripheral Equipment

The auxiliary machines which may be placed under the control of the central computer, e.g., card readers and punches, magnetic tape feeds, high-speed printers.

Printer (line)

A device capable of printing one line of characters across a page simultaneously as continuous paper advances line by line in one direction past type bars or a type cylinder that contains all characters in all positions.

Procedure Program

A computer program written in ISL-1 by the course author or programmer detailing the steps to be followed by the computer during CBI processing.

Program

The complete plan for the solution of a problem, including data gathering, processing, and reporting; more specifically, the complete sequence of instructions and routines necessary to solve a problem. To plan the procedures for solving a problem.

Random Access

(1) Pertaining to the process of obtaining information from or placing information into storage, where the time required for such access is independent of the location of the information most recently obtained or placed in storage; (2) pertaining to a device in which random access can be achieved without effective penalty in time.

Read

To transfer information from an input device to internal or auxiliary storage; to sense information contained in some source.

Response Time

The elapsed time between generation of an inquiry at a terminal and receipt of a response by the system.

Software

The totality of programs and routines used to extend the capabilities of computers, e.g., compilers, assemblers, executive routines, etc.

Source Language

The original form in which a program is prepared prior to processing by the machine. Instructional Language-1 is the source language used for procedure programs in the CBI system.

Source Program

A computer program written in a language designed for ease of expression of a class of problems or procedures, e.g., symbolic or algebraic.

Statement

A meaningful expression or generalized instruction in a source language.

Storage Capacity

The number of elementary pieces of data (e.g., characters of bytes) that can be contained in a storage device.

Store

To transfer an element of information to a device from which the unaltered information can be obtained at a later time; to retain data in a device from which it can be obtained at a later date.

Student History Vector

A CBI record reflecting a student's daily progress in the course. The Student History Vector file is maintained and updated through both procedure program processing and off-line processing.

Syntax

The rules governing sentence structure in a language, or statement structure in a language such as that used for a compiler.

System

A group of procedures, processes, methods, routines, or techniques related by some form of regulated interaction to form an organized whole.

Teletype

A typewriter like device used as input/output to student.

Terminal

A device in a communication network capable of sending and/or receiving information over a communications channel.

Time Out

A condition which occurs when a student fails to complete a response in the time allotted by the course author.

Time-Sharing

The use of a device for two or more purposes during the same overall time interval, accomplished by interspersing component activities in time.

Tutorial

Pertains to functions exercised by a tutor, i.e., instruction to an individual or a small group of students. In CBI, the tutorial mode involves instruction rather than testing, and is contrasted with drill and practice.

Update

To make changes in a file required by correct information or transactions.

Word

An ordered set of characters occupying one storage location and treated by the computer circuits as a unit.